"THE DUST WAS LONG IN SETTLING": HUMAN CAPITAL AND THE LASTING IMPACT OF THE AMERICAN DUST BOWL

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Abstract: I use variation in childhood exposure to the Dust Bowl, an environmental shock to health and income, as a natural experiment to explain variation in adult human capital. I find that the Dust Bowl produced significant adverse impacts in later life, especially when exposure was *in utero*, increasing rates of poverty and disability, and decreasing rates of fertility and college completion. Dependence on agriculture exacerbates these effects, suggesting that the Dust Bowl was most damaging via the destruction of farming livelihoods. This collapse of farm incomes, however, had the positive effect of reducing demand for child farm labor and thus decreasing the opportunity costs of secondary schooling, as evidenced by increases in high school completion amongst the exposed.

Keywords: Dust Bowl, environmental shock, human capital formation, early life health

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> "All day the dust sifted down from the sky, and the next day it sifted down. An even blanket covered the earth…Every moving thing lifted the dust into the air: a walking man lifted a thin layer as high as his waist, and a wagon lifted the dust as high as the fence tops, and an automobile boiled a cloud behind it. The dust was long in settling back again."
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> — John Steinbeck, *The Grapes of Wrath* (1939, pp. 6, 4)

1. INTRODUCTION

The American Dust Bowl, a prolonged ecological event characterized by drought, accelerated soil erosion, and severe dust storms, represents one of the most devastating environmental catastrophes in American history (Worster 1979). During this crisis, which lasted throughout the 1930s, a series of dust storms ravaged the US Great Plains, destroying land, property, and agricultural livelihoods; disrupting public services; and causing injury to health and nutrition (Carlson 1935; Worster 1979; Hansen & Libecap 2004; Burns et al 2012; Hornbeck 2012a). Recent literature indicates that early-life shocks and interventions can radically change the course of human capability formation, and thus shape adult outcomes (Barker & Osmond 1986; Almond 2006; Heckman 2007; Cunha & Heckman 2008; Almond et al. 2009; Almond & Currie 2011b; Bhalotra & Venkataramani 2012). In light of this literature, the Dust Bowl's shocks to health and incomes would be expected to have non-negligible adverse effects on wellbeing in later-life; however, these long-run human costs have been little studied (Cutler et al. 2007).

In this paper, I analyze the long-term consequences of the Dust Bowl for the human capital of the children who lived through it. Specifically, I use exogenous variation in the severity of this environmental shock across space—proxied by Dust Bowl soil erosion—to explain variation in adult human capital and socioeconomic outcomes. I thus test for the degree to which the Dust Bowl scarred human capital in the long run, the mechanisms by which any such scarring occurred, and the way parental investment in human capital responded to the shock. I find that exposure to the Dust Bowl in childhood has statistically significant and economically meaningful adverse impacts on later-life outcomes, for instance, increasing disability and reducing fertility and college completion. Furthermore, I find that the Dust Bowl's adverse impacts are more severe for those born in more agriculture-dependent states. Similarly, its effects on health and poverty outcomes are strongest amongst those exposed *in utero*, while those for secondary education are strongest for those exposed in late childhood. Lastly, results imply that parental investment post-shock likely compensated for rather than reinforced child endowments.

Together, these findings suggest that the Dust Bowl produced its greatest adverse impacts through falls in agricultural incomes, and thus acted primarily as an economic shock that in turn affected health. Indeed, direct, personal exposure to the Dust Bowl in childhood, for instance, via dust inhalation, was less important to later-life poverty and disability than indirect exposure to the Dust Bowl's effects *in utero*. These outcomes are likely due to fetal maldevelopment resulting from poor maternal health and nutrition, conditions themselves stemming from a combination of maternal dust exposure and material deprivation (Barker & Osmond 1986; Heckman 2007; Cunha & Heckman 2008; Almond & Currie 2011a & 2011b). Similarly, the lower rates of college completion amongst the exposed, especially where exposure occurred earlier in childhood, suggest that congenital complications in capability development, together with low parental incomes *in utero* and thereafter, are to blame. Indeed, where child ability and parental incomes were no object, as in secondary education, outcomes are counterintuitively positive: high school completion rates among the exposed rise dramatically. Here too, livelihoods play a role, as the collapse of farming incomes likely lowered the opportunity cost of schooling as child farm labor opportunities became fewer. Tests of the influence of farm-dependence on parental investment responses suggest that those exposed to the Dust Bowl in more agricultural states likely received lower rates of compensating investment than did those exposed in less agricultural states, for reasons including lower returns to human capital investments in agricultural communities following the destruction of farms. The findings in this study are consistent with a multi-stage model of human capability formation, in which investments in one period respond to endowments in a previous one, and may either reinforce or compensate for these endowments (Heckman 2007).

1.1. Related Literature

America's Dust Bowl

During the period from 1930 to 1940, poor rainfall and strong winds over land that had been cultivated expediently over the preceding decades precipitated a series of massive dust storms across the US Great Plains (Stephens 1937; Lord 1938; Wallace 1938; Hansen & Libecap 2004; Cunfer 2005). [1] These storms blew away roughly 480 tons of fertile topsoil per acre, with many regions in the plains having lost over 75% of their original topsoil by 1940 (Hansen & Libecap 2004; Hornbeck 2012a). By blowing soil away altogether, winds wrought permanent damage and destroyed agricultural productivity; they decimated existing crops through exposure and abrasion, and prevented new ones from being planted (Soil Conservation Service 1935; Lord 1938; Bennett 1939). Dirt deposited downwind suffocated livestock, buried property, and smothered yet other crops (Soil Conservation Service 1935; Worster 1979; Hansen & Libecap 2004; Egan 2006). Accordingly, agricultural yields were low (Bennett 1939; Bonnifield 1979; Cutler et al. 2007) and recovery was slow (Hornbeck 2012a).

The Dust Bowl was not just an environmental crisis, but a human tragedy as well (Carlson 1935; Worster 1979; Hurt 1981; Egan 2006; Burns et al. 2012). As the country struggled with the Great Depression, the Dust Bowl compounded misfortunes, especially for the farming communities of the Great Plains (Wallace 1938; Cutler et al. 2007). Economic hardship was widespread: meager harvests meant low incomes, nutritional deprivation—and, for many, farm foreclosure, eviction, and migration (Bonnifield 1979; Worster 1979).

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[1] In the evocative words of Gove Hambidge in his executive summary in Wallace (1938), "water and wind have flayed the skin off the unprotected earth, causing widespread destruction."

More directly, dust storms were both an everyday nuisance and a health hazard to Great Plains inhabitants (Agricultural Adjustment Administration, cited in Cunfer 2005). Poor air quality and dust inhalation led to respiratory illnesses such as "dust pneumonia" and asthma, which were often life-threatening (Soil Conservation Service 1935; Worster 1979; Hurt 1981; Hansen & Libecap 2004; Egan 2006; Burns et al. 2012). Eye infections and influenza, too, were reported at greater rates in Dust Bowl-affected counties (Hansen & Libecap 2004). Furthermore, these storms and the associated economic hardships disrupted schooling directly, by lowering attendance in response to dangerous weather conditions, and indirectly, by prompting taxpayers to cut or cease funding to schools (Soil Conservation Service 1935; Worster 1979; Hansen & Libecap 2004; Egan 2006; Burns et al. 2012).[2] Such prolonged stress also had a psychological dimension: what had once been home became surreal and terrifying, "as nearly a literal hell on earth as can be imagined." (Lord 1938). Demoralized residents felt uncertain and powerless, under constant siege by the environment and subject to a litany of indignities large and small (Lord 1938; Steinbeck 1939; Worster 1979; Egan 2006; Burns et al. 2012).

The Dust Bowl's impacts on land management and conservation, agricultural recovery, and migration have been well studied (Worster 1979; Helms et al. 1996; Hansen & Libecap 2004; Cunfer 2005; Cook et al. 2009; Hornbeck 2012a); however, a gap exists in the literature. Although qualitative sources on the Dust Bowl's short-term health effects abound, only one study, which using different data sources and methods found limited Dust Bowl effects, has attempted to quantify the long-term human costs of the natural disaster (Cutler et al. 2007). As a result, it is possible the literature currently underestimates the damage caused by the Dust Bowl. By quantifying the later-life impacts of the Dust Bowl on human capital, I corroborate qualitative accounts on near-term health effects and contribute to our understanding of the full toll of this seminal event in American history.

Early-Life Health and Human Capability Formation

Current research indicates that stress, deprivation, and early-life shocks to income and health can have long-term adverse impacts on health and wellbeing (Barker & Osmond 1986; Cutler et al. 2007; Heckman 2007; Almond & Currie 2011b; Bhalotra & Venkataramani 2012). Human capital development may be impaired not only directly through childhood illness, but also indirectly, through poor prenatal conditions (that is, maternal stress, illness, or malnutrition) or through low incomes and nutritional deprivation in early life. These poor early-life circumstances in turn hamper the successful development of capabilities such as cognitive skills, non-cognitive skills, metabolism, and immunity (Ravelli et al. 1999; Roseboom et al. 2000; Cutler et al. 2007; Heckman 2007). For instance, infections such as pneumonia in early life have been shown to subvert cognitive development by producing an inflammatory response that diverts resources from normal mental development processes as survival is prioritized (Bhalotra & Venkataramani 2012). Similarly, experiences of famine in early life have been implicated in later-life coronary

[2] Egan (2006) suggests that demand for schools and teachers existed, and that school closures were largely due to lack of funding.

heart disease and schizophrenia.[3] In turn, such low stocks of human capital may negatively impact other wellbeing outcomes such as later-life income and employment (Heckman 2007; Bhalotra & Venkataramani 2012). Given the destruction of livelihoods and the direct health and educational disruptions documented during this period (Worster 1979; Nealand 2008; Burns et al. 2012), Dust Bowl survivors are likely to suffer just such adverse effects on human capital formation.

The Dust Bowl offers an opportunity to test for the effects of an event fundamentally different in nature from the sorts of shocks more often studied in the literature. Firstly, it represents a prolonged experience of stress and deprivation more akin to famine (Ravelli et al. 1999; Roseboom et al. 2000; Rasmussen 2001; Almond et al. 2007; Ó Gráda 2009 & 2011) than to the sharp shocks—for instance, a sudden disease outbreak, an educational policy change, or health intervention—studied in works such as Duflo (2001), Almond (2006), Bleakley (2007), and Bhalotra & Venkataramani (2012). The fact that individuals may have had greater time to respond to this shock, and may have even adjusted to it while the event was still ongoing, adds to the range, realism, and complexity of early-life shocks studied.

Secondly, studying the Dust Bowl allows me to analyze the impact of what is ultimately an agrarian economic shock resulting from an environmental catastrophe. While studies of the health impacts of environmental disasters exist (Cutler et al. 2007; Almond et al. 2009), much of the research in human capital formation focuses on shocks and interventions directly related to health;[4] fewer still track the effect of short-term physiological and developmental changes and subsequent investment responses on adult outcomes (Bhalotra & Venkataramani 2012). The fact that the Dust Bowl constitutes an economic shock allows me to show that incomes acted through childhood health and education to produce lasting effects in adults—in this case, permanent damage to health and socioeconomic status.

I also contribute to our understanding of the technology of human capital formation. By testing for parental investment responses to exogenous, Dust Bowl-induced changes in children's human capital endowments, I disentangle changes in human capital which result from the shock itself from those resulting from investments made to ameliorate or reinforce these changes to the endowment. Specifically, by combining variation in Dust Bowl exposure with farm-dependence-based variations in returns to human capital investments,[5] I identify regions where compensating investments may have responded to local labor market conditions and thus resulted in poorer recovery from childhood insults. I find individuals born in more agriculture-dependent states experience worse adverse outcomes consistent with low returns to human capital in farming, suggesting that exposed

[3] See overview of famine and fetal programming literature in Rasmussen (2001) and Ó Gráda (2011).

[4] A great many studies, like Almond (2006), Bleakley (2007), and Bhalotra & Venkataramani (2012) focus on shocks and interventions directly targeting health; however, studies like Dehejia & Lleras-Muney (2004), Banerjee et al. (2010), and Adhvaryu et al. (2013) focus on the adverse health outcomes induced by shocks to childhood income, and Duncan and Brooks-Gunn (1997) on those due to (chronic) childhood poverty.

[5] My approach follows the technique used in Bhalotra & Venkataramani (2012), in the context of race-based access to good institutions and its influence on returns to human capital across races and regions. See also Almond et al. (2009).

children in more agricultural states received less investment in their post-shock recovery. Thus, I provide empirical support for theories of self-productivity and dynamic complementarity in capability formation, such as those advanced by Becker & Tomes (1976) and Heckman (2007).

The remainder of the paper proceeds as follows. In Section 2, I describe my methodological approach, including identification strategy and data. In Section 3, I outline results, with a focus on tests of the mechanisms by which the Dust Bowl impacted later-life health and wellbeing. In Section 4, I combine these findings to explain how childhood economic shocks resulted in increases in secondary schooling alongside permanent health damage, and to discuss the implications of agriculture-dependence and public spending results in light of an existing model of human capital formation. In Section 5, I conclude.

2. IDENTIFICATION STRATEGY & DATA

2.1. Identification Strategy

I exploit exogenous environmental shocks to income and health—in the form of Dust Bowl-induced soil erosion—to identify impacts on later-life human capital outcomes. I use a differences-in-differences strategy to identify the treatment impact of Dust Bowl exposure, with a baseline regression as follows, estimated by OLS:

$$h_i = \alpha + \beta_1 \times \text{treated}_b \times \text{erosion}_s + x_i'\psi + \theta_s + \lambda_b + \eta_t + \gamma_s + u_i \tag{1}$$

Here, h_i represents the later-life human capital outcome of interest for individual i born in year b in state s and observed in census year t.

The term $treated_b \times erosion_s$ is the chief variable of interest in this paper, and refers to whether or not an individual was a child during the Dust Bowl and whether they were exposed to high erosion. It may thus be interpreted as the reduced form effect of childhood Dust Bowl exposure on adult outcomes.

$Treated_b$ is equal to 1 for individuals aged -1 to 12 at any time during the Dust Bowl[6] so as to capture the effects of the shock during childhood, which has been defined so as to span the period *in utero* up to the onset of puberty.

$Erosion_s$ is a variable representing the erosion intensity in a given state over the Dust Bowl period—that is, "treatment" by the Dust Bowl, where treatment refers to the degree of exposure to this random environmental shock. Since county-level erosion is known but county of birth is not, in the baseline, erosion_s is constructed as the proportion of the state population in 1930 living in high-erosion counties within that state, and so may be interpreted as the probability an individual born in a given state was born into a high-erosion county.

[6] That is, all children born between 1918 and 1941, inclusive.

Furthermore, since census data do not allow for the identification of those who may have migrated away from the state of birth during childhood, the $treated_b \times erosion_s$ term may be interpreted as an intent-to-treat estimate. Thus, the coefficient on the $treated_b \times erosion_s$ variable, β_1, describes the causal effect of Dust Bowl treatment relative to those not exposed. As such, a negative sign on β_1 implies that Dust Bowl exposure during childhood reduces the human capital outcome of interest, while a positive β_1 implies Dust Bowl exposure raises the human capital outcome. Whether such a rise (β_1>0) or fall (β_1<0) is interpreted in practical terms as a beneficial versus as an adverse effect will of course depend on the desirability of the outcome in question. For instance, reductions in the probability of college completion or the number of children ever born would be considered adverse effects since lower values for these outcomes reflect damage to education and reproductive health; while reductions in welfare income or the probability of physical disability, for contrast, would represent beneficial impacts since lower values here reflect higher socioeconomic status and better health.

x_i represents a vector of controls (in the baseline, the individual's race; outside the baseline, race and veteran status at an individual level, state-level drought, and birth state-birth year per capita income).

Lastly, θ_s, λ_b , and η_t represents birth state fixed effects, birth year fixed effects, and census year fixed effects, respectively, while γ_s represents state trends. Together, the set of individual controls and fixed effects allow me to control for individual characteristics, such as race, that may affect the degree to which Dust Bowl exposure manifests in later-life human capital, as well as to remove the effects of any time-invariant state heterogeneity (such as differences by state in quality of land), unobserved heterogeneity across time (such as differences by birth year in per capita income or public service expenditure), and unobserved heterogeneity across census waves (such as systematic differences in enumeration methods). The inclusion of state trends further allows me to strip away the effects of larger-scale trends in outcomes during this period, such as the baby boom or declining ages at marriage (see Figures WA1b & WA1a in Section 4 of the Web Appendix, respectively), such that β_1 may be interpreted as the causal effect of Dust Bowl exposure above and beyond these phenomena. Note that the un-interacted $treated_b$ and $erosion_s$ terms have been excluded for collinearity with, and are instead absorbed by, the birth year (λ_b) and birth state (θ_s) fixed effects, respectively.

Standard errors are clustered at the birth state and birth year levels so as to adjust for serial correlation in outcomes (Bertrand et al. 2004), and the equation is estimated separately for males and females in order to identify differences by gender in Dust Bowl impacts.[7]

The preceding description has outlined the baseline specification; details of robustness checks and further tests are discussed in Section 3.

[7] My approach closely resembles that in Bhalotra & Venkataramani (2012).

2.2. Data

Dust Bowl Severity

To identify the scope and intensity of Dust Bowl exposure, I use measures of soil erosion for 15 Great Plains and adjacent states[8] (see Figure 1a), taken from the US Soil Conservation Service. Beginning in 1934 in response to the Dust Bowl and continuing over its course, the Soil Conservation Service conducted comprehensive surveys of soil conditions across the United States, identifying thousands of regions of erosion classified by the severity (e.g. slight, moderate, severe) and type (e.g. sheet, wind, gullying) of erosion damage observed (Soil Conservation Service 1935). By 1948, the office had created the first of a series of maps cataloging the cumulative erosion experienced throughout the entire Dust Bowl period (Hornbeck 2012a). I take my erosion figures from this 1948 map, which characterizes erosion severity by percentage of original topsoil lost: high (75% or more), medium (25-50%), and low (0-25%) erosion (Hornbeck 2012a). To control for possible changes to county boundaries during the Dust Bowl period, per Hornbeck (2012a), 1910 county boundary definitions are enforced for measures of erosion, population, and farm value (Hornbeck 2012a). For further discussion of the Soil Conservation Service and its erosion maps, see Hornbeck (2012a).

Since the severity of the Dust Bowl in human terms depends on population distribution over space within a given state, I weight erosion measures by population, taken from the US Census,[9] such that states with a greater proportion of population residing in high-erosion counties are deemed to have been more severely treated by the Dust Bowl. Erosion measures are constructed on the state level so as to correspond to individual outcomes, which can only be measured at the birth state level.[10]

Although the 1948 map captures the erosion wrought by many of the Dust Bowl's worst storms, such as April 1935's Black Sunday (Carlson 1936; Choun 1936; National Weather Service: Norman Oklahoma Weather Forecast Office 2013), a notable weakness of the erosion data is the lack of baseline erosion measures, since no erosion surveys were made prior to 1934 (Soil Conservation Service 1935; Hornbeck 2012a). In order to account for possible measurement error due to the absence of information on pre-1930 erosion levels,

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[8] The states in the sample account for 23% of US population in 1930 (U.S. Census Bureau 2002a & 2002b), and 47% of US landmass in 1930 (U.S. Census Bureau 2013). The choice of these 15 states accords with qualitative and quantitative accounts such as the Soil Conservation Service (1935), the Great Plains Committee (cited in p. 669 of Hansen & Libecap 2004), Worster (1979), Hansen & Libecap (2004), Nealand (2008), and Hornbeck (2012a), that place the epicenter of the Dust Bowl in the Great Plains region and nearby states. Indeed, previous studies using erosion-based methodologies to study Dust Bowl phenomena, such as Hansen & Libecap (2004) and Hornbeck (2012a), have used a similar sample of states. By including states on either side of the core Great Plains region, I ensure sufficient variation in erosion severity to allow for differences-in-differences analysis. For further discussion of the states included in the sample, see Section 2 of the Web Appendix.

[9] Included in Hornbeck (2012b) dataset; for underlying sources, see Hornbeck (2012a).

[10] IPUMS data and censuses do not include more granular information on nativity, such as birth county or birth city.

I substitute data from the US Census of Agriculture[11] on the percentage change in farm values between 1930 and 1940 for the $erosion_s$ term in (1) as a robustness check, since 1930 farm values provide a useful proxy for the quality of land prior to the Dust Bowl. As a further robustness check, I substitute Dust Bowl drought for erosion as the measure of Dust Bowl severity. For this analysis, I use state-level climate station data on rainfall during the 1930-40 period, taken from the National Oceanic and Atmospheric Administration (2013) and constructed, using the SPI method, as the total magnitude of all drought events in the state during the period (McKee at al. 1993; see Section 2 of the Web Appendix). Maps detailing severity of Dust Bowl exposure by measures of erosion, change in farm values, and drought are detailed in Figures 1b-1d.

Human Capital Outcomes

Data on later-life health, educational, and socioeconomic outcomes for individuals born between 1900 and 1959, inclusive, is taken from the Integrated Public Use Microdata Series (IPUMS), a dataset culled from US Census responses, which are reported every 10 years (Ruggles et al. 2010). Given the timeframe of the Dust Bowl, I use 5%-sample data collected in the 1980, 1990, and 2000 US Censuses to capture stable adult outcomes of those who were children, as defined in Section 2.1, between 1930 and 1940—that is, individuals born between 1918 and 1941, inclusive.[12]

The IPUMS data contains individual-level information on demographics, employment and income, educational attainment, and disability (Ruggles et al. 2010); my analysis tests for the effects of Dust Bowl exposure on outcomes such as age at first marriage, children ever born, probability of high school completion, and probability of cognitive disability. Furthermore, via disaggregation by developmental stage cohort, this data allows me to test for both direct (e.g. respiratory illness, absence from school) as well as indirect (e.g. poor nutrition due to low incomes, developmental complications due to poor maternal health) effects of Dust Bowl exposure in childhood.

Summary statistics on adult outcomes by gender are available in Table 1. Graphs of outcome summary statistics by gender and year, with 95% confidence intervals, are provided in Figures WA1a-WA1j in Section 4 of the Web Appendix.

3. RESULTS

3.1. Overall

I begin by testing the impact of Dust Bowl exposure on later-life outcomes across all males and females. Table 2 lists the values for β_1 from equation (1) for each of the later-life outcomes considered. I find that individuals exposed to the Dust Bowl as children suffered permanent and damage to human capital and wellbeing on a scale that is both statistically

[11] Included in Hornbeck (2012b) dataset; for underlying sources, see Hornbeck (2012a).
[12] Those who were children (that is, 0-12) during the Dust Bowl would be aged roughly 40-62 years in 1980.

and economically significant, with magnitudes similar to those found in studies such as Bhalotra & Venkataramani (2012) and those reviewed in Almond & Currie (2011a).

Under the baseline specification in column (1), I find that exposed women have a 1.17% lower probability of completing college, and a 0.466% higher probability of living in poverty, defined as living at or below the census poverty line (see Section 2 of the Web Appendix). The poverty effects for men are even starker: exposed men have a 0.802% greater likelihood of living in poverty than men who were not exposed, as well as a receipt of $15.05 more in welfare payments. Furthermore, exposed men have a 1.1% greater chance of experiencing physical disability.

In column (2), percentage change in farm values between 1930 and 1940 takes the place of erosion as the measure of Dust Bowl severity. Percentage change in farm value is a particularly useful proxy for Dust Bowl exposure since it does not penalize states that may naturally experience poor land quality or higher levels of pre-1930 erosion, traits that the baseline model would attribute to Dust Bowl effects. Under this specification, I find similar effects on poverty and welfare payments. However, a number of additional impacts are also statistically significant: exposed men see a nearly quarter-year reduction in the age at marriage, and a 1.12% greater chance of experiencing self-care and independent mobility disability; exposed women see a $15.37 increase in welfare receipt, as well as 1.45%, 0.942%, and 1.29% increases in cognitive, vision and hearing, and self-care and independent mobility disabilities, respectively. Exposed women also experience 3.71% greater likelihoods of high school completion than their unexposed counterparts. The positive effects of Dust Bowl exposure on high school completion may at first seem counterintuitive. However, as will be discussed in Section 3.2 with reference to agricultural communities, increases in the rates of secondary schooling reflect the drop in the opportunity cost of schooling as farms, and thus, the need for child farm and household labor, collapsed.[13] These results stand as a contrast to college completion rates, which fall amongst the exposed, and in which arena child cognitive ability was a likely barrier (Heckman 2007).

In column (3), when the sum of the magnitudes of all drought events during the period 1930 to 1940 takes the place of erosion in the baseline equation, the signs are as in columns (1) and (2), although the magnitudes are slightly larger (for instance, a shift from the least to the most drought-affected state in the sample—that is, a 126-point or roughly four-fold increase in drought magnitude—would entail a 5.37% increase in high school completion for women, as opposed to a 3.71% increase under (2), or a 1.47% increase in the probability of cognitive disability for women, as opposed to a 1.45% increase under (2)) and the effects on a greater number of outcomes, such as age at marriage for women, and probability of completing high school for men, are statistically significant.

[13] Worster (1979) discusses the collapse of agriculture in the Great Plains during the Dust Bowl, while Whaples (2005) finds extensive child farm labor in the 10-15 age range in 1930. McNay et al. (2005) indicates the link between profitable child labor opportunities and schooling rates, noting that poor opportunities for child labor can raise schooling rates by lowering the opportunity cost of schooling. See Section 4 for a more detailed discussion.

Results are intuitive, and are consistent with the literature on childhood shocks (Almond 2006; Almond et al. 2007; Almond et al. 2009; Banerjee et al. 2010; Ó Gráda 2010): the Dust Bowl had negative consequences for health, human capital, and indicators of wellbeing, increasing poverty and disability, and decreasing ages at marriage and college completion.

Furthermore, results are consistent with historical and qualitative scholarship on the Dust Bowl (Worster 1979; Burns et al. 2012): the stress, deprivation, poor nutrition, and ill health documented as short-term consequences of the catastrophe are manifest in the later-life disability and poverty outcomes seen here, while low Dust Bowl incomes, coupled with cognitive and developmental problems, are likely to blame for the lower rates of postsecondary education observed. In Section 3.2 I test these hypotheses as to the mechanisms through which the Dust Bowl produced the effects discussed here; indeed, I show that many of the Dust Bowl's adverse effects stem from low incomes and developmental complications in early life.

Lastly, the magnitudes of impact I find in the baseline specification and beyond are in line with many studies on early-life shocks and interventions. For instance, Almond (2006) finds a roughly 1-2% higher chance of work disability amongst men exposed to the 1918 flu pandemic, a figure similar to the increases in disability I find. My estimates of the reduction in the probability of college completion (roughly 1-3%) and the increase in disability rates (roughly 1-2%) are also similar in magnitude to the effects on those variables found in Bhalotra & Venkataramani (2012), which tracks the effects of a pneumonia vaccine introduction.[14] For further discussion of the magnitudes of impact of childhood health shocks on later life outcomes, see Bhalotra & Venkataramani (2012), p. 32 and Almond & Currie (2011a), which provides a comprehensive survey of similar studies.

3.2. Mechanisms

In Tables 3-7, I report results on tests of the pathways and mechanisms through which the Dust Bowl affects later-life outcomes, both in terms of the environmental insult, and in terms of investment responses to it. First, I use farm population-weighted erosion measures test the hypothesis that individuals born in more agriculture-dependent states experienced worse adverse effects of Dust Bowl exposure—that is, that the income channel effects of the Dust Bowl mattered. I also use farm status interactions test whether individuals born in states with greater levels of farm-dependence experienced worse Dust Bowl effects than those in less agricultural states. Here, the aim is to test whether state-level gradients in the returns to human capital investment led in turn to greater initial insults and/or lower compensatory investments in individuals growing up in farming states. Second, I disaggregate the analysis to test whether the presence or severity of adverse effects is linked to the developmental stage at which children were exposed to the

[14] Notably, since Bhalotra & Venkataramani (2012) studies a positive intervention, the signs are generally the opposite of those I find. Surprisingly, I also find positive effects on high school completion similar both in sign and magnitude to those in Bhalotra & Venkataramani (2012).

Dust Bowl. Lastly, I test for the effects of public spending, primarily associated with the New Deal, in ameliorating adverse effects on children's health, nutrition, and education.

Agriculture

In Table 3, I test for the impact of the Dust Bowl on more agriculture-dependent states. I find that agriculture-dependence exacerbates the adverse effects of the Dust Bowl.

Columns (1) for men and (3) for women present the β_1 values for regressions in which the $erosion_s$ variable in equation (1) is weighted by proportion of farm population rather than by proportion of overall population, such that erosion is defined as the proportion of the state's farm population living in high erosion counties (see Section 2 of the Web Appendix). That is, in these regressions, it is the proportion of the population in farming that matters—if a county hit by the Dust Bowl contained no farmers, it would not be considered exposed to the Dust Bowl, and would not contribute to the state's erosion level. This measure of erosion allows me to test for the effects of the Dust Bowl on states based on the degree to which they depended on agricultural livelihoods. Although individuals' household farm status in childhood is unknown, the measure used here is still helpful since even non-farmers in agriculture-dependent regions would have found their fortunes intimately linked to the success or failure of agriculture; for instance, shop owners or local creditors serving a largely agricultural clientele would surely suffer from the collapse of farming incomes (Burns et al. 2012), while the destruction of farming livelihoods would also have an impact on local tax bases and thus public service provision for all in a given community, regardless of occupation (Worster 1979).

Under this specification, exposed women see a reduction in fertility of 0.345 children ever born, as well as a 2.09% decrease in the probability of completing college, the latter outcome nearly twice as severe as that in the baseline. Exposed women are 0.771% likelier to be living in poverty than their unexposed counterparts, while for men, the impact is even starker, with a 1.27% increase in the likelihood of poverty. Exposed men similarly have a 1.73% increase in the probability of physical disability, a figure roughly 50% more severe than the adverse impact in the baseline specification.

Columns (2) for men and (4) for women report the β_1 and β_2 coefficients for regressions in which a binary variable for agriculture dependence (defined as 1 where the proportion of the state's population engaged in agriculture in 1930 is above average for the sample; see Section 2 of the Web Appendix) is interacted with the original $\text{treated}_b \times \text{erosion}_s$ term, as follows:

$$h_i = \alpha + \beta_1 \times \text{treated}_b \times \text{erosion}_s + \beta_2 \times \text{farm}_s \times \text{treated}_b \times \text{erosion}_s + x_i'\psi + \theta_s + \lambda_b + \eta_t + \gamma_s + u_i \quad (2)$$

As was discussed with respect to $treated_b$ and $erosion_s$ in equation (1), here the un-interacted $farm_s$ term is absorbed by the state fixed effect, θ_s.

I thus test for how farm-dependence modified the Dust Bowl shock, namely, whether individuals exposed to the Dust Bowl in farming states received lower levels of compensating investment than their peers non-farming states. Since farm communities may have seen lower returns to human capital investments, especially following the Dust Bowl, these individuals would be expected to suffer in later life even while others recovered from the Dust Bowl shock.[15] Adverse effects here can be interpreted in three ways. First, they may be seen as a more dramatic initial insult due to the Dust Bowl shock, under the assumption that farm children were poorer and more deprived than their non-farm counterparts prior to the Dust Bowl, and that this made them more susceptible to a shock of equivalent size. Relatedly, as discussed above, it is possible that the shock represented by erosion was actually larger in farming communities than elsewhere, since erosion likely undermined farming incomes more so than other livelihoods. Second, they may be interpreted, as Bhalotra & Venkataramani (2012) and Almond et al. (2009) generally do, as a poorer compensatory investment response in children who would enjoy low returns to human capital investments as a result of the collapse of their chief industry, farming.[16]

Here, statistically significant adverse effects are similar to those in (1) and (3). I find that agriculture-dependence made the effects of Dust Bowl exposure more severe (i.e. larger in magnitude), although its contribution (β_2) to the overall impact is smaller than the simple effect of Dust Bowl exposure (β_1). These results suggest that individuals growing up in non-farm states received higher rates of compensating investment to aid in their recovery from the shock than did those in states dependent on agriculture.

A notable exception is found in the probability of high school completion. Here, for men but not for women, $\beta_2 > \beta_1$. Men exposed to the Dust Bowl in farm states experience high school completion rates 3.818% higher than those of unexposed men, and 2.92% higher than those for exposed men from non-farm states, who themselves have a 0.898% higher chance of completing high school than the unexposed. For contrast, amongst exposed farm-state women, $\beta_1 > \beta_2$. That farm status appears to amplify the high school completion effect of Dust Bowl exposure more for men than for women accords with the fact that boys were more active than girls in agricultural child labor (Whaples 2005), such that when farms failed, their opportunity cost of schooling rose more sharply than that of their sisters.

Lastly, as found under the regressions weighting erosion by farm population, in specifications where the $farm_s$ variable in equation (2) is a continuous rather than binary measure of the proportion of the state's population engaged in agriculture in 1930 (not reported), exposed women in more agriculture-dependent states have 2.256 fewer children than those not exposed—a meaningful reduction in a sample where the mean number of children born is 2.4.

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[15] As in the case of race in Bhalotra & Venkataramani (2012).

[16] Per Bhalotra & Venkataramani (2012), who find that racial barriers in access to institutions lowers returns to human capital amongst African-Americans, and thus reduces responsive investments by parents.

Tellingly, it is only in the farm specifications that the adverse effect on fertility for women become statistically significant, indicating that girls born into more agriculture-dependent states during the Dust Bowl had fewer children over the course of their lifetimes. Since higher ages at marriage and higher rates of college completion indicative of long-term career planning, per Goldin & Katz (2002) and Bailey (2006), are not found for these women, nor are lower levels of income in adulthood that might induce women to restrict fertility, these fertility declines are most likely due to early-life developmental complications in reproductive health. This finding is particularly striking given the nationwide post-war "baby boom" trend in fertility experienced by the generation born in the 1920s and 1930s (see Figure WA1b in Section 4 of the Web Appendix).

Developmental Stage

In order to pinpoint the effect of the age at which the Dust Bowl shock occurs, I estimate equation (1), substituting the proportion of a given developmental age band spent during the Dust Bowl period for the original $treated_b$ term. Thus, where all those aged -1 to 12 at any point between 1930 and 1940 would have been counted as treated on a binary basis, now each individual receives a duration-weighted measure of exposure during each development stage, which are defined as follows: -1 to 0 (*in utero*/neonatal), 1 to 3 (infancy), 4 to 6 (early childhood), 7 to 9 (prime school age), and 10 to 12 (early adolescence). See Section 2 of the Web Appendix for further discussion of development stage measures.

In Table 4 I report the β_1 values from these of regressions for men, and in Table 5 for women. Patterns by outcome and developmental stage are also plotted in Figures WA2-WA11 in Section 4 of the Web Appendix. I find that age at exposure matters, both to the severity of adverse effects and to the significance of effects; indeed, disentangling effects by developmental stage allows me to clarify pathways of impact that the baseline or overall regressions obscure.

For men, adverse effects on poverty, disability, and age at marriage outcomes are worst amongst those exposed *in utero* and in infancy. Men exposed during the -1 to 0 age band get married 0.21 years younger, and those exposed between ages 1 and 3 get married 0.193 years younger; notably, these negative effects on age at marriage for the treated cohorts are found above and beyond the national trend in declining ages at marriage during the period (see Figure WA1a in Section 4 of the Web Appendix), and could be interpreted as an attempt by these men to build an identity and signify adulthood through marriage or family where opportunities to define oneself through one's work or occupation were elusive. Men exposed from ages -1 to 0 receive $16.29 more in welfare income, while those exposed from 1 to 3 receive $14.15 more. Physical disability rates rise as well: men exposed *in utero* are 1.69% likelier to suffer physical disability, while those exposed in infancy are 1.89% likelier to be physically disabled. Adverse effects appear to dampen as the age of exposure rises, except notably in disability outcomes; in the early adolescence period, shocks that in early childhood produced greater likelihoods of physical disability instead produce lower likelihoods of physical and vision and hearing disabilities.[17]

These findings are consistent with the idea that congenital health defects are responsible for poor later-life outcomes. While disability outcomes may be intuitively understood to result from the Dust Bowl's effects on fetal/infant nutrition and health, we might, for contrast, expect poor adult socioeconomic outcomes to result from poor labor market readiness, perhaps due to deficits in schooling attributable to shocks at school-going age. However, given that the greatest adverse impacts for poverty and age at marriage outcomes are found in early childhood, the results suggest that poor health and development complications may be to blame, perhaps acting through disability, or even directly, to produce lower adult socioeconomic status.

Secondary schooling appears to be the exception to the infant exposure pattern. Those exposed in late childhood—that is, school age and beyond—enjoy better outcomes than their unexposed counterparts in high school completion: men exposed between the ages of 7 and 9 see a 3.42% greater chance of finishing high school; amongst men exposed between 10 and 12, the increase in the probability of high school completion is 3.61%. Although the notion that a shock at schooling age would affect schooling is intuitive, finding *positive* outcomes on schooling may appear less intuitive at first glance. However, the age at impact for this outcome, together with the results on farm-dependence, suggest that secondary schooling rates may have risen as the collapse of agricultural incomes reduced chances for child labor and decreased the opportunity cost of schooling.

For women, fertility outcomes are negatively affected across developmental stages, while college completion, poverty, and disability effects are worst in early childhood, and high school completion rates are most positively affected in later childhood.

Women exposed to the Dust Bowl from ages 1 to 12 face a 0.184 to 0.268-child reduction in fertility, with the greatest adverse impact occurring in the 4 to 6 age range. That fertility reduction effects are greatest well before puberty, and that they occur in the absence of rises in age at marriage or in labor force participation, suggests early damage to reproductive health, perhaps through poor nutrition or endocrinal maldevelopment. This non-negligible decline in fertility amongst women exposed to the Dust Bowl is especially remarkable in light of the baby boom experienced by their unexposed counterparts in the 1918-1941 birth cohort.

Women exposed between the ages -1 and 6 also had a 1.36-1.54% lower chance of completing college, with the greatest adverse effects accruing to those exposed *in utero*. A similar pattern follows for probability of poverty (0.728% higher for those exposed -1 to 0 and 0.509% higher for those exposed 1 to 3) and for physical disability (1.28% higher for those exposed *in utero*) and self-care and independent mobility difficulty (0.574% higher for those exposed *in utero*). As was the case for men, chances of disability decrease in later

[17] These findings are consistent with theory in Heckman (2007), Cunha & Heckman (2008), and Almond & Currie (2011a).

childhood, and the greatest positive effects on secondary schooling occur amongst schooling-age children: an increase of 4.89% in the probability of high school completion amongst women exposed between ages 7 and 9, and an extraordinary 6.39% increase amongst those exposed between 10 and 12.

For both men and women, the preponderance of adverse effects for health- and ability-related outcomes in early childhood suggest that the pathway of impact is largely through problems in capability formation, while the positive effects observed for secondary schooling in later childhood implicate labor markets and access to public services.

Public Spending Responses

In attributing any recovery experienced by Dust Bowl children to compensatory household investments in human capital, I may be ignoring the role of state expenditure on Dust Bowl relief—for instance, cash assistance, farm loans, or the building of schools, hospitals, and roads. I thus test for the effect of New Deal and related public expenditure in attenuating Dust Bowl impacts.

As above, I interact measures of total state-level per capita public spending over the period (Fishback et al. 2003; alternately, relief expenditure, which includes grants for the Works Progress Administration, Federal Emergency Relief Administration, and Public Assistance; New Deal expenditure, which encompasses relief grants and includes further expenditures such as those on the construction of roads and public buildings; and loans, which includes those made in aid of farms and housing)[18] with the measure of Dust Bowl treatment as follows:

$$h_i = \alpha + \beta_1 \times \text{treated}_b \times \text{erosion}_s + \beta_2 \times \text{publicspending}_s \times \text{treated}_b \times \text{erosion}_s + \beta_3 \times \text{publicspending}_s \times \text{treated}_b + x_i'\psi + \theta_s + \lambda_b + \eta_t + \gamma_s + u_i \quad (3)$$

The results from these regressions are reported in Table 6 (for men) and Table 7 (for women). Public expenditure through the New Deal and associated programs are found to attenuate the adverse effects of Dust Bowl exposure in large and statistically significant ways.

Relief spending in particular appears to mitigate the effect of Dust Bowl exposure: a one standard deviation increase in per capita relief spending raises exposed men's ages at marriage by 1.208 years, reduces welfare income by $60.13, and reduces work disability, vision and hearing disability, and self-care and independent living disability by 0.885%, 4.485%, and 2.051%, respectively. Exposed women similarly see a 0.839 year rise in age at marriage given a one standard deviation increase in per capita relief spending, although they also experience a puzzling 8.8% increase in physical disability.

[18] Data compiled for Fishback et al. (2003), and accessed at http://www.u.arizona.edu/~fishback/Published_Research_Datasets.html; see Fishback et al. (2003) for details of the variables' construction, sources of the underlying data, and discussion of New Deal-era programs.

Per capita loans similarly ameliorate adverse impacts on male college completion and on female work disability, albeit to a smaller degree: a one standard deviation increase in per capita loans associated with a 0.662% greater chance of completing college, and the same increase in spending contributing to 0.516% lower rates of work disability amongst exposed women.

New Deal expenditures, meanwhile, are associated with higher probabilities of high school completion among both exposed men (5.930% for a one standard deviation increase in spending) and exposed women (3.258%). Given that loans and New Deal spending are associated with higher probabilities of high school completion amongst the exposed, but relief spending has the opposite effect, perhaps spending was most effective on improving secondary schooling outcomes where it was targeted at agricultural recovery and infrastructural investment.

Whatever the mechanism, state spending aimed at Depression and Dust Bowl recovery appears to have been effective in compensating for early-life insults and diminishing the worst Dust Bowl impacts on human capital—in particular those on disability and schooling.

3.3. Robustness

Results are robust to the definition of Dust Bowl severity—that is, the alternate thresholds of the $erosion_s$ term in equation (1). Results are also survive alternate definitions of the timing of Dust Bowl exposure ($treated_b$ in equation (1)), such as those just discussed, that narrow the treatment period from childhood as a whole to specific developmental age ranges spent during the Dust Bowl period.

Results for specifications including controls for veteran status (to account for possible G.I. Bill benefit effects on postsecondary education and income/wealth; Altschuler & Blumin 2009) and drought (to account for Dust Bowl effects not fully captured by erosion alone[19]) are similar to those obtained in the baseline (not reported).

Results are also robust to alternate means of clustering and to the removal of trends (not reported). Under these less rigorous specifications—first, clustering by birth state alone, and second, removing state trends—the signs and magnitudes of β_1 remain intuitive and similar to those in the baseline. As might be expected of these specifications, many more coefficients are statistically significant: most notably, those on high school completion (effects large and positive) and age at marriage (effects large and negative).

Confounding Factors & Threats to Inference

The period under study coincides with three major phenomena that could be said to have confounded effects here attributed to Dust Bowl exposure: the Great Depression, which could have affected childhood incomes independently of the Dust Bowl; migration from the Great Plains to the American West, which could have affected duration of treatment and

[19] Cunfer (2005) and Hornbeck (2012a) draw the distinction between drought and erosion effects and timing.

sample selection; and selection into (fertility) or out of (mortality) the sample. Below I outline why these issues are unlikely to undermine my analysis and findings.

The Great Depression

First, the differences-in-differences model is designed to exploit both spatial and temporal variation in Dust Bowl exposure (Angrist & Pischke 2009). As such, it tests for the effect of differences in severity of Dust Bowl exposure even within cohorts in which all individuals were exposed to the Depression. Thus, as long as Depression severity was relatively uniform across the states in the sample, as is suggested by the similar ratios obtained across states of state per capita income at various stages of the Depression to 1929 baselines (Bureau of Economic Analysis 2012), β_1 isolates the treatment effect of the Dust Bowl above and beyond any effects of the Great Depression.

Second, I control for a variety of fixed effects and trends that account for state-by-state variation in economic performance or shocks beyond those due to the Dust Bowl. These include birth year fixed effects, which control for nationwide macroeconomic shocks; birth state fixed effects, which take into account a state's level of economic development; and state trends, which capture trends in state income, economic performance, and public spending over time. Only if the Depression's effects varied dramatically within a state (for instance, spatially or demographically) might the latter two controls be insufficient to capture the average effect of the Depression on all individuals in a given state. Controls for an individual's actual household income during childhood would thus be ideal, however these figures are not available in the census.

Lastly, in the absence of information on actual childhood household circumstances, I include controls for state-level childhood income meant to proxy for Great Depression effects (Fishback & Thomasson 2014). Although state-level income in childhood is found to be reasonably significant in statistical and economic terms, and has an intuitive impact on outcomes such as disability, results on Dust Bowl exposure are robust to the inclusion of these controls (reported in the Section 3 of the Web Appendix), which include state per capita personal income in the birth year, state per capita personal income in the year before birth, and average state per capita personal income over childhood (ages -1 to 12), all in 1982-4 dollars (Easterlin 1957; Sahr 2007; Klein 2009; Bureau of Economic Analysis 2012; see Section 2 of the Web Appendix for details of construction). These results suggest the Dust Bowl had adverse effects above and beyond those due to the Depression; indeed, it is likely that the Dust Bowl, and not just macroeconomic shocks, contributed to the low incomes experienced in this period by the Great Plains states in the sample.

Migration

First, since migration status during childhood is unknown, as discussed in Section 2.1, equation (1) proceeds as an intent-to-treat analysis and should not be interpreted as a measure of actual treatment. As such, the estimates of adverse effects presented here are a lower bound on the true treatment effects of the Dust Bowl. Indeed, regressions disaggregating adult outcomes experienced by the (eventual, possibly childhood) migrants from those of non-migrants in my sample indicate that migrants had wellbeing outcomes similar to or better than non-migrants, again suggesting that the adverse effects presented here are less severe than those experienced by actual exposed non-migrants (methodology discussed and results reported in Section 3 of the Web Appendix). Furthermore, the severity of Dust Bowl exposure in childhood does not have an effect on eventual migration: regressions of the effect of Dust Bowl exposure on migrant status as adults show no statistically significant effects of exposure on the decision to migrate for men or women (see Section 3 of the Web Appendix).

Second, it is unlikely that even individuals migrating as children would have escaped treatment during the most critical phase for the shaping of outcomes: the -1 to 0 developmental stage for which I find the strongest adverse impacts of exposure, and which represents a narrow and precarious window in a family's life cycle during which out-migration is unlikely to have occurred. Indeed, regressions of the likelihood of a child having migrated between birth and age 12 on Dust Bowl exposure and a variety of individual and household characteristics, indicate that neither Dust Bowl severity of treatment nor measures of household income and socioeconomic status, conditional on Dust Bowl treatment, are significant in determining the likelihood of migration in childhood (methodology discussed and results reported Sections 1 & 3 of the Web Appendix). The only significant difference is found in Dust Bowl-exposed children from farm households, who were if anything *less* likely to have migrated before age 12 than the nonfarm exposed. As such, interstate migration during the childhood treatment window is unlikely to influence exposure measures.

Third, it is unclear whether out-migrants would have had systematically different characteristics than those who stayed in the sample region and thus would have been treated (or would have responded to insults) heterogeneously, for instance, by wealth; while some accounts suggest that those with the means to migrate did, yet others suggest that those who held greater land and wealth felt tied to these assets and were thus reluctant to leave (Lord 1938; Wallace 1938; Worster 1979; Nealand 2008; Burns et al. 2012). The regressions on childhood migrants discussed above, wherein household characteristics on the whole have no significant impact on migrant status, corroborate these qualitative accounts.

Fertility Selection

Work on crisis events such as famine and macroeconomic busts indicates that often in such periods, only those who can afford to provide for children will choose to continue bearing them (Dehejia & Lleras-Muney 2004; Ó Gráda 2011). If such a phenomenon were at play during the Dust Bowl, I would expect that the individuals likely to be most resilient to and most capable of compensating for the Dust Bowl shock would disproportionately enter my sample, while many of the most vulnerable would never been born at all, thus overstating adult wellbeing and underestimating the adverse effects of the shock.

I test for such fertility selection into my sample using census data and find no statistically significant differences in fertility between higher- and lower-socioeconomic status women in response to the Dust Bowl (methodology discussed and results reported in Sections 1 & 3 of the Web Appendix). Similar analysis using vital statistics corroborates that birth rates and erosion timing/severity have little relationship: states experienced no significant change in birth rates during the Dust Bowl period (see Section 3 of the Web Appendix), a finding consistent with Cutler et al. (2007) and Fishback et al. (2007).

Mortality Selection

Given that the individuals in the Dust Bowl cohort are aged 39-62 when I first observe them as adults in the 1980 Census, and are 59-82 by the time I observe them for the final time in 2000, survivorship bias may be a concern. That is, it is possible that many of the individuals in poorest health as a result of Dust Bowl exposure may have died at some point before being observed in 1980, a "culling" effect that would bias the health and wellbeing outcomes of individuals appearing in my sample upwards. If such an effect existed, my results would in fact underestimate the true adverse effects of the Dust Bowl on health.

Testing for differences in yearly state-level stillbirth rates and infant mortality rates, I find no significant change in either measure of early-life mortality (methodology discussed and results reported in Section 3 of the Web Appendix). Similarly, I test for whether the Dust Bowl cohort had significantly higher mortality rates at any stage (under age 1, 1-4, 5-14, 15-24, 25-34, 45-54, 55-64, 65-74, and 74-85) up to and including my observation period, than those not exposed. I find no significant difference in mortality rates by age bin for the Dust Bowl cohort, except for in the 5-14 age bin, during which boys in the Dust Bowl cohort experienced marginally (0.406 point) lower mortality rates than those not exposed, and in the 55-64 age bin, during which men exposed to the Dust Bowl as children experienced a 3.212-point lower mortality rate than their unexposed counterparts (methodology discussed and results reported in Sections 1 & 3 of the Web Appendix). These findings indicate that mortality selection and survivorship bias are unlikely to influence my results.

4. CONCEPTUAL FRAMEWORK & DISCUSSION

4.1. Conceptual Framework

The results presented here are consistent with Heckman's (2007) model of human capability development wherein investments at different stages of development have nonlinear effects, and where such inter-temporal investments are complementary rather than perfectly substitutable. Heckman (2007) proposes the following constant elasticity of substitution function:

$$h = A\,[\,\gamma \times I_1^{\phi} + (1 - \gamma) \times I_2^{\phi}\,]^{1/\phi} \tag{4}$$

wherein the effect on human capital, h, of the allocation of the total investment $I_1 + I_2$ between periods 1 and 2 will depend not just on the share parameter, γ, but also, crucially, on the inter-temporal elasticity of substitution, $1/(1-\phi)$. This model allows for both dynamic complementarity in investment, or the notion that investments in a later period are more productive at higher levels of capability in the previous period, and self-productivity in investment, or the notion that higher capability levels in an earlier period create higher levels of capability in a later one (Almond & Currie 2011a).

It is also useful to consider the role of the parent's (p) utility, which trades off parental consumption, C, for the child's human capital as follows, assuming a Cobb-Douglas utility function:

$$U_p = (1 - \alpha) \times \log C + \alpha \times \log h \tag{5}$$

subject to a budget constraint:

$$Y_p = C + I_1 + I_2/(1+r) \tag{6}$$

Thus, if a child suffers in period 1 the Dust Bowl shock D, which is negative and independent of I_1, the function will be:

$$h = \mathrm{A}\,[\,\gamma \times (I_1 + D)^{\phi} + (1 - \gamma) \times I_2{}^{\phi}\,]^{1/\phi} \tag{7}$$

meaning the that the choice of I_2 will be a function of I_1, D, and Yp as parents respond to the shock by converting consumption, C, into child capabilities, h.[20]

The decision of whether to compensate for the shock D at all, or whether to reinforce it, will of course depend on the value of ϕ. Where ϕ>0, parents will make compensatory investments, and where ϕ<0, they will instead reinforce the shock (Almond & Currie 2011a).

4.2. Discussion

The results presented in Section 3 indicate that the primary pathway of impact on later-life health was likely through poor prenatal and early-life conditions, rather than through direct health and educational insults in later childhood, such as respiratory illness or school absence. Furthermore, evidence of unsuccessful fetal development suggests the role of Dust Bowl-related income shocks that lowered levels of maternal nutrition, and made mothers both more vulnerable and less resilient to health shocks such as respiratory disease. Added to the evidence presented here indicating that the Dust Bowl's effects were more severe amongst the more farm-dependent, it is possible the Dust Bowl should be interpreted as a fundamentally economic shock that had permanent health consequences.

The finding that disability outcomes are determined *in utero* and within the first year of life is intuitive enough, given the literature on fetal programming that suggest that earlier

[20] See Almond & Currie (2011a) for further discussion of the effect $\frac{\partial h}{\partial D}$ of the shock D on human capital outcomes h, which in the case of ϕ =1 depends only on the share parameter γ, and in the case of imperfect inter-temporal substitutability, implies diminishing marginal productivity of investments.

developmental stages disproportionately influence many health outcomes (that is, per the conceptual framework, $\gamma>0.5$). However, it is striking that this indirect and early-life development pathway would also be responsible for outcomes like college completion and poverty, which might more intuitively be associated with direct disruptions in schooling and labor-market preparation occurring in later childhood. Indeed, given that high school completion rates rise amongst the exposed, why did not college completion rise as well, and poverty levels fall with this acquisition of education? Why does college behave like a health outcome? The answer might be that cognitive and physical impairments accrued *in utero* as a result of maternal poverty and ill-health influenced individuals' ability to enter and complete college, to hold down jobs, and to earn income as adults. That these impairments were not fully remediated by adulthood is consistent with Heckman's (2007) model, in which investments in later periods (i.e. further in time from the shock), are less productive.

Even the intriguing results showing substantial increases in high school completion amongst those exposed suggest the important role of income shocks, namely to agriculture (Worster 1979; Cutler et al. 2007).[21]

Prior to the Dust Bowl's destruction of farms, child farm labor was prevalent. Whaples (2005) shows that in 1930, 74.5% of boys and 61.5% of girls aged 10-15 were employed in agriculture, and Clay et al. (2012) indicate that child labor was extensive even in the face of compulsory schooling laws, which were not strictly enforced. Laws restricting child labor, such as the 1938 Fair Labor Standards Act, contained many exemptions for child labor in agriculture, especially on family farms (U.S. Department of Labor, 2007 & 2013). Thus, the collapse of agriculture in the Great Plains had scope to reduce opportunities for child labor. Child labor, schooling, and the opportunity cost of schooling have been shown to be closely related (McNay et al. 2005; Bhalotra 2007; Clay et al. 2012). For instance, in the context of present-day developing countries, Bhalotra (2007) finds that lowering the opportunity cost of schooling, in her case through cash transfers meant to offset the child's wages, is essential to reducing child labor and increasing schooling. Poverty may have remained an issue for Dust Bowl households, but for them, the lack of opportunities for labor in agriculture, whether for children or adults, likely drove a drop in the opportunity cost of schooling. Indeed, McNay et al. (2005) find this phenomenon at play where higher rates of girls' schooling in 19th Century Britain are found in regions where opportunities for girls' (but not boys') employment were few.

Consistent with such an explanation that links agricultural child labor and schooling, I find high school completion rates surged amongst those exposed to the Dust Bowl in prime schooling age (7-12), a period which also corresponds to the ages at which children may have been employed in household and farm work (U.S. Department of Labor 2007). Furthermore, I find evidence that Dust Bowl effects were more severe in more agriculture-

[21] Ó Gráda (2011) discusses a phenomenon in the famine literature by which many wellbeing outcomes are actually improved by exposure, although these impacts are generally the result of mortality and fertility selection and are more numerous than the positive effects seen here, for instance, on high school completion.

dependent states. Together, these facts imply that a reduction in the need for child labor in agriculture following the destruction of farms and the collapse of agricultural incomes may have lowered the opportunity cost of secondary schooling for school-age (i.e., working-age) children who now had no more profitable way to spend their time.[22] Of course, increased high school completion rates also reflect increased public spending[23]—for instance, on school-building—as a response to the natural disaster, just as public spending on poverty reduction has been shown above to attenuate disability likelihood amongst the exposed.

Notably, high school and college completion rates are affected at different developmental stages: the former in late childhood, and the latter prenatally. This contrast underlines the importance of childhood time allocation concerns to primary and secondary school attendance decisions (Moehling 1999; McNay et al. 2005; Bhalotra 2007; Clay et al. 2012), and the cognitive and intellectual capability barriers to college entry and completion (Heckman 2007). While for present-day households, credit constraints have been found less important than cognitive ability in determining college enrollment (Heckman 2007), it should be noted that the same low incomes that may have played a role in producing poor college outcomes through poor fetal nutrition and thus cognitive impairments *in utero,* may also have produced poor college outcomes through constraints on a parent's ability to afford college, per equations (5) and (6) in the conceptual framework.

Results show that public spending on recovery, that is, the state's contribution to I_2, helped mitigate the Dust Bowl's adverse effects—but what role did parental investment responses play? The results on farm-dependent individuals suggest that non-farm parents did indeed make compensating investments in child human capital, as evidenced by the fact that adverse outcomes were less severe for those in less farm-dependent states.[24] That is, the evidence of responsive investment suggests that investments across periods are relatively elastic; that is, $\phi>0$, even if its value may be small. Here, however, it is difficult to determine whether farm-dependence made individuals more susceptible to shocks (for instance, because I_1 was lower for these children than for their non-farm counterparts), thus lowering their endowment at the end of period 1 by a greater degree for an equivalent-sized shock than in less farm-dependent states; whether they received a more potent shock for an equivalent level of erosion, which is likely since it directly affected agriculture; or whether lower returns to human capital investment caused parents in more agricultural states to make investments that reinforced rather than compensated for losses in the child's human capital endowment, losses which would have been equivalent to the initial losses sustained by those in less farm-dependent states.

Furthermore, given that farm incomes were affected, the failure of households to make compensatory investments need not be taken as evidence of a strategic decision to reinforce the lowered child endowment. For instance, poor farm households such as these

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[22] Egan (p. 99, 2006) provides anecdotal evidence that the lack of profitable farming work during the Dust Bowl freed children up for other pursuits, namely, school.

[23] Fishback et al. (2006) discuss infrastructure projects, such as school construction, completed under the New Deal, as well as the intra-state migration response to these projects.

[24] Alternately, it is possible to conclude that individuals in non-farm states merely had their shock reinforced to a lesser degree.

may have faced credit constraints such as those in equation (6), limiting the possibility of investment in health and education, even where the parental will to invest existed. Similarly, parents may have invested less in ameliorating health insults if their investment and consumption decisions anticipated a lack of old-age support from their children (Bhaskar & Gupta 2012), especially in light of the absence of a social safety net the likes of which would eventually be implemented as a part of the New Deal (Social Security Administration 2005). However, if the findings here on investment are interpreted as in Bhalotra & Venkataramani (2012), these imply that households made compensating rather than responsive investments in human capital, a finding that is striking since much of the literature on human capital upholds a reinforcing-investments explanation of shock- and intervention-response even while the multi-stage model of human capital formation outlined in section 4.1 allows for the possibility of compensating investments, for instance, in early childhood, when these investments are most likely to be productive and efficient.[25]

The fact that I find evidence of mitigation of adverse Dust Bowl effects in both public spending and household contexts suggests that indeed $\phi>0$. However, the fact that recovery is incomplete, in tandem with the finding that those exposed in earlier developmental stages suffer worse outcomes than those struck later on in life, gives credence to theories of self-productivity and dynamic complementarity in investment, and furthermore indicates that investments in human capital are not in fact perfectly substitutable (that is, $\phi\neq1$). Thus, as Heckman (2007) and Almond & Currie (2011a) suggest, the common assumption that investments have linear effects across childhood is unrealistic.

Furthermore, and especially pertinent to the case of the 1930s, which saw the Dust Bowl and the resultant collapse of family farming on top of the macroeconomic effects of the Great Depression, it is worth noting that particularly low incomes (Yp) may have allowed little scope for re-channeling funds intended to be spent on meager, subsistence consumption (C) towards post-shock investments (I_2). Here, New Deal loans and cash transfers appear to have helped alleviate the household constraint.

5. CONCLUSION

Using a differences-in-differences approach, I leverage variation in Dust Bowl exposure in childhood to explain variation in adult human capital and socioeconomic outcomes. Testing for the shock's impact at different developmental stages, and for the shock-modifying effects of agriculture-dependence and public spending responses, allows me to identify the channels through with the Dust Bowl had greatest adverse effect.

Through this analysis, I show that the Dust Bowl had meaningful long-term health and human capital costs for those exposed as children. For women, fertility and college

[25] Almond et al. (2009) and Bhalotra & Venkataramani (2012) find empirical evidence of reinforcing investments; Heckman (2007) and Almond & Currie (2011a) discuss the possibility of compensatory investments where investments in different periods are substitutable.

completion rates fell, while poverty rates rose. For men, age at marriage fell, while poverty rates, welfare receipts, and disability rates rose. Notably, the adverse effects on the preceding outcomes were most severe for those exposed *in utero* and in early childhood, implicating an indirect health pathway—that is, poor prenatal nutrition and health, and through it, disrupted capability development—in the production of these impacts.

For all, but especially for women, high school completion rates rose; these impacts, for contrast, were greatest amongst children in late childhood and early adolescence, when the tradeoff between child farm labor and formal schooling likely dictated time use. Thus, when agricultural livelihoods fell off, as indicated both by the secondary literature and by the income-pathway effects shown here among the farm-dependent, the opportunity cost of schooling likely fell, prompting increased high school attendance but not college attendance, where cognitive ability—which suffered as a result of Dust Bowl exposure—was a barrier to entry.

Results comparing individuals from farm-dependent states with their non-farm counterparts suggest that households made human capital investments that primarily compensated for rather than reinforced poor initial endowments. Similarly, New Deal and related public expenditure are found to have attenuated the Dust Bowl's adverse effects.

As intent-to-treat rather than treatment-on-the-treated estimates, my results represent the lower bounds on the actual later-life effects of childhood Dust Bowl exposure. This intent-to-treat design stems from a limitation in census data: the absence of information on individuals' circumstances as children. Since only an individual's birth state is listed in the census, adult outcomes cannot be linked to childhood erosion at a more localized level, making it difficult to accurately gauge an individual's actual Dust Bowl exposure. I do, however, take steps to account for the likely level, timing, and duration of exposure. First, I employ county-level population-weighting in the construction of state-level erosion variables which allows for a more realistic measure of spatial variation in the severity of exposure within a state. Second, I disaggregate exposure by developmental stage. Along similar lines, since census data do not allow for analysis of the effects of differences in parental characteristics or household farm and socioeconomic status in childhood, I include controls and farm population weights that provide a rough proxy for childhood economic circumstances. Together, these strategies attempt to overcome the data's limitations until the expiry of the 72-year rule for this generational cohort allows for back-linkage through censuses to actual, granular childhood residency and household details.

The results presented here represent an important contribution to our understanding of the impacts of the Dust Bowl; namely, they show quantitatively that exposed children suffered long-term and practically meaningful damage to health and human capital, and that there is a role for compensating investments in mitigating environmental insults to health.[26] This study also offers policy-relevant findings, for example, adding to the

[26] Almond et al. (2009) in the case of a negative shock and Bhalotra & Venkataramani (2012) in the case of a positive intervention emphasize the role of reinforcing investments.

literature urging intervention in child labor as a means of boosting schooling,[27] and substantiating the hypothesis that college-readiness is largely determined *in utero* and in early childhood and suggesting that postsecondary educational interventions should be targeted accordingly (Heckman 2007; Cunha & Heckman 2008). Perhaps most intriguing is the finding that economic shocks can have as large an effect on health as shocks directly targeting health.

[27] Either in complement with schooling reforms per Clay et al. (2012) and Basu (1999) or via alleviation of poverty constraints per Bhalotra (2007); rather than through child labor restrictions, which have been shown in Moehling (1999) to be ineffective in influencing schooling outcomes, or through anti-child labor trade sanctions, which Basu (1999) suggests can expose children to poverty and more hazardous work.

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Table 1 — Summary Statistics

	All		Men		Women	
	Mean	N	Mean	N	Mean	N
Age at First Marriage	22.09	1,379,007	23.47	638,996	20.90	740,011
Children Ever Born	2.40	1,601,986			2.40	1,601,986
Probability of Completing High School	0.70	1,590,689	0.70	760,484	0.70	830,205
Probability of Completing College	0.15	1,590,689	0.18	760,484	0.12	830,205
Welfare Income	101.08	4.256,983	73.56	1,997,206	125.41	2,259,777
Probability of Poverty	0.12	4,256,983	0.10	1,997,206	0.14	2,259,777
Probability of Cognitive Disability	0.08	4,256,983	0.07	568,197	0.09	657,791
Probability of Physical Disability	0.19	1,225,988	0.17	568,197	0.21	657,791
Probability of Vision & Hearing Difficulty	0.08	1,225,988	0.09	568,197	0.08	657,789
Probability of Self-Care & Independent Mobility Difficulty	0.12	2,666,294	0.10	1,236,722	0.14	1,429,572

Table 2 — Impact of Childhood Exposure to the Dust Bowl on Later-Life Outcomes

	Baseline (1)		Δ Farm Values (2)		Drought (3)	
	Men	Women	Men	Women	Men	Women
Age at First Marriage	-0.132 (0.139)	-0.00343 (0.123)	-0.249* (0.128)	-0.152 (0.121)	-0.00347*** (0.00036)	-0.00278*** (0.0004)
Children Ever Born		-0.206 (0.132)		0.0659 (0.115)		0.00147* (0.00081)
Probability of Completing High School	0.0169 (0.0152)	0.0307 (0.0192)	0.0236 (0.0165)	0.0371** (0.0176)	0.000209** (8.74E-05)	0.000425*** (8.68E-05)
Probability of Completing College	-0.0107 (0.0075)	-0.0117** (0.00536)	-0.0000172 (.00908)	-0.00678 (0.00552)	5.30E-05 (8.51E-05)	-7.34E-05 (5.48E-05)
Welfare Income	15.05* (9.147)	16.54 (10.2)	22.83*** (6.884)	15.37** (6.414)	0.215*** (0.0465)	0.0566 (0.121)
Probability of Poverty	0.00802* (0.00419)	0.00466* (0.00278)	0.0111* (0.00577)	0.00363 (0.00645)	7.63e-05*** (2.91E-05)	3.83E-05 (2.58E-05)
Probability of Cognitive Disability	0.00654 (0.00685)	-0.00538 (0.00618)	0.003 (0.0102)	0.0145** (0.00655)	9.76e-05*** (3.55E-05)	0.000116*** (3.11E-05)
Probability of Physical Disability	0.0110*** (0.00408)	-0.0021 (0.011)	0.00687 (0.0102)	-0.0144 (0.00908)	-5.93E-06 (5.06E-05)	-0.000217*** (7.62E-05)
Probability of Vision & Hearing Difficulty	-0.00273 (0.00662)	-0.00228 (0.005)	0.00802 (0.00667)	0.00942** (0.00369)	0.000102* (5.38E-05)	-1.87E-05 (3.43E-05)
Probability of Self-Care & Independent Mobility Difficulty	-0.00028 (0.00388)	-0.00146 (0.00293)	0.0112* (0.00475)	0.0129*** (0.00425)	5.26e-05*** (1.71E-05)	-1.62E-05 (3.58E-05)

*** p<0.01, ** p<0.05, * p<0.1; Note: Table reports $treated_b$*$erosion_s$ coefficients. Each row in the left-hand column refers to the regression's dependent variable, while the remaining column headings indicate the definition of Dust Bowl severity (i.e. $erosion_s$) used. All regressions are estimated by OLS and include controls for race; birth year, birth state, and census year fixed effects; and state trends. Standard errors, clustered by birth state and birth year, are reported in parentheses below each coefficient. To aid in interpreting the drought interaction coefficient, the minimum, maximum, and standard deviation for drought variable in the full sample are as follows: 40.350, 166.650, 38.837.

Table 3 — Impact of Exposure to the Dust Bowl by Mechanism: Agriculture

	Farm Pop	Farm * Erosion		Farm Pop	Farm * Erosion	
	(1)	(2)		(3)	(4)	
	Men			Women		
		Main	Interaction		Main	Interaction
Age at First Marriage	-0.219 (0.211)	-0.132 (0.135)	1.04E-05 (0.109)	-0.056 (0.186)	0.0241 (0.111)	-0.101 (0.0778)
Children Ever Born				-0.345* (0.199)	-0.122 (0.0857)	-0.311 (0.214)
Probability of Completing High School	0.0318 (0.0211)	0.00898 (0.0108)	0.0292* (0.0168)	0.0473 (0.0297)	0.0264* (0.0152)	0.016 (0.0294)
Probability of Completing College	-0.0153 (0.012)	-0.0103 (0.00711)	-0.0014 (0.00503)	-0.0209*** (0.00736)	-0.0110** (0.00478)	-0.00232 (0.00998)
Welfare Income	21.47 (15.22)	17.29** (8.093)	-8.124 (16.02)	23.26 (17.23)	21.51** (9.576)	-18.2 (13.88)
Probability of Poverty	0.0127* (0.00696)	0.0103** (0.00513)	-0.00835 (0.0089)	0.00771* (0.00425)	0.00683* (0.0038)	-0.00795* (0.00459)
Probability of Cognitive Disability	0.0114 (0.0107)	0.00411 (0.00556)	0.00645 (0.0124)	-0.00832 (0.0102)	-0.00331 (0.00388)	-0.0074 (0.0134)
Probability of Physical Disability	0.0173*** (0.00617)	0.00974*** (0.00335)	0.00437 (0.0106)	-0.00348 (0.0187)	-0.00794 (0.0134)	0.0208 (0.0211)
Probability of Vision & Hearing Difficulty	0.00104 (0.0106)	-0.00306 (0.00697)	0.00114 (0.00645)	-0.00464 (0.0084)	-0.00315 (0.00415)	0.00312 (0.0112)
Probability of Self- Care & Independent Mobility Difficulty	-0.00121 (0.0061)	0.00041 (0.00339)	-0.00247 (0.00541)	-0.00224 (0.00482)	-0.00309 (0.00275)	0.0059 (0.00597)

*** p<0.01, ** p<0.05, * p<0.1; Note: Columns 1 & 4 report $treated_b$*$erosion_s$ coefficients for specifications in which erosion severity is weighted by county-level farm population rather than general population. Columns 2 & 4 report $treated_b$*$erosion_s$ coefficients (main effect) and *interaction*$treated_b$*$erosion_s$ coefficients (interaction effect) for specifications that interact the baseline treatment term with the state's proportion of population engaged in farming. All regressions are estimated by OLS and include controls for race; birth year, birth state, and census year fixed effects; and state trends. Standard errors, clustered by birth state and birth year, are reported in parentheses below each coefficient.

Table 4 — Impact of Exposure to the Dust Bowl by Development Stage on Later-Life Outcomes: Men

	Men				
	-1 to 0 (1)	1 to 3 (2)	4 to 6 (3)	7 to 9 (4)	10 to 12 (5)
Age at First Marriage	-0.21* (0.113)	-0.193* (0.114)	-0.0743 (0.113)	0.039 (0.114)	0.0368 (0.125)
Probability of Completing High School	-0.00524 (0.0139)	0.0105 (0.0133)	0.0188 (0.0124)	0.0342*** (0.0127)	0.0361** (0.0167)
Probability of Completing College	-0.011 (0.0103)	-0.00883 (0.00815)	-0.00719 (0.00648)	-0.00222 (0.00584)	-0.00237 (0.00631)
Welfare Income	16.29** (6.794)	14.15* (8.37)	5.762 (7.673)	8.366 (8.306)	5.422 (8.606)
Probability of Poverty	0.00387 (0.00323)	0.00311 (0.00365)	0.00402 (0.0037)	0.00426 (0.00358)	0.00651 (0.00402)
Probability of Cognitive Disability	0.0116 (0.00757)	0.00264 (0.00834)	-0.00592 (0.00729)	-0.0114 (0.0076)	-0.0121 (0.00948)
Probability of Physical Disability	0.0169*** (0.00423)	0.0189*** (0.0045)	0.0062** (0.00274)	-0.00539 (0.00839)	-0.0164** (0.00816)
Probability of Vision & Hearing Difficulty	0.00674 (0.00542)	0.00812 (0.0068)	-0.001 (0.00803)	-0.0114 (0.00799)	-0.0154* (0.00863)
Probability of Self-Care & Independent Mobility Difficulty	0.00253 (0.00411)	-0.00236 (0.00414)	-0.00784** (0.00381)	-0.00569 (0.00424)	-0.00507 (0.00433)

*** p<0.01, ** p<0.05, * p<0.1; Note: Table reports $treated_b$*$erosion_s$ coefficients. Each row in the left-hand column refers to the regression's dependent variable, while the remaining column headings indicate the developmental stage that defines $treated_b$. All regressions are estimated by OLS and include controls for race; birth year, birth state, and census year fixed effects; and state trends. Standard errors, clustered by birth state and birth year, are reported in parentheses below each coefficient.

Table 5 — Impact of Exposure to the Dust Bowl by Development Stage on Later-Life Outcomes: Women

	Women				
	-1 to 0 (1)	1 to 3 (2)	4 to 6 (3)	7 to 9 (4)	10 to 12 (5)
Age at First Marriage	-0.0757 (0.115)	-0.0384 (0.129)	0.0329 (0.125)	0.0574 (0.132)	0.0768 (0.105)
Children Ever Born	-0.165 (0.103)	-0.241* (0.131)	-0.268* (0.138)	-0.238* (0.132)	-0.184* (0.111)
Probability of Completing High School	-0.0128 (0.00901)	-0.00072 (0.0129)	0.0203 (0.0178)	0.0489** (0.0221)	0.0639** (0.0278)
Probability of Completing College	-0.0154*** (0.00397)	-0.0136*** (0.00354)	-0.0144** (0.00633)	-0.0104 (0.00651)	-0.00481 (0.0064)
Welfare Income	14.9** (7.103)	14.19 (9.361)	10.85 (9)	13.47 (11.07)	12 (11.38)
Probability of Poverty	0.00728*** (0.00275)	0.00509* (0.0028)	0.00103 (0.00308)	0.00227 (0.00235)	0.000504 (0.00334)
Probability of Cognitive Disability	0.00821 (0.00532)	3.35E-05 (0.00599)	-0.00702 (0.00486)	-0.0153*** (0.00427)	-0.0208*** (0.00226)
Probability of Physical Disability	0.0128* (0.00713)	0.00538 (0.00786)	-0.0119 (0.00952)	-0.0191** (0.00935)	-0.0252** (0.00999)
Probability of Vision & Hearing Difficulty	0.00109 (0.00424)	0.00287 (0.00375)	-0.00079 (0.00398)	-0.00433 (0.00499)	-0.00513 (0.00582)
Probability of Self-Care & Independent Mobility Difficulty	0.00574* (0.00321)	-0.00023 (0.00296)	-0.00751** (0.00321)	-0.0104** (0.00487)	-0.00994* (0.00604)

*** p<0.01, ** p<0.05, * p<0.1; Note: Table reports $treated_b$*$erosion_s$ coefficients. Each row in the left-hand column refers to the regression's dependent variable, while the remaining column headings indicate the developmental stage that defines $treated_b$. All regressions are estimated by OLS and include controls for race; birth year, birth state, and census year fixed effects; and state trends. Standard errors, clustered by birth state and birth year, are reported in parentheses below each coefficient.

Table 6 — Impact of Exposure to the Dust Bowl by Mechanism: Public Spending - Men

	New Deal * Erosion (1)		Relief * Erosion (2)		Loans * Erosion (3)	
	Main	Interaction	Main	Interaction	Main	Interaction
Age at First Marriage	-0.259 (0.242)	0.000754 (0.00211)	-3.974*** (1.164)	0.0529*** (0.016)	-0.0758 (0.342)	-0.00173 (0.00389)
Probability of Completing High School	-0.151*** (0.0309)	0.00125*** (0.00025)	0.326*** (0.111)	-0.00422*** (0.00146)	-0.088*** (0.025)	0.00148*** (0.00031)
Probability of Completing College	-0.0227 (0.0162)	9.50E-05 (0.0001)	0.00116 (0.0889)	-0.00017 (0.00115)	-0.0313** (0.0148)	0.000278* (0.00016)
Welfare Income	7.179 (20.96)	0.0743 (0.174)	202.8*** (54.61)	-2.586*** (0.737)	1.791 (21.36)	0.26 (0.26)
Probability of Poverty	-0.0154 (0.0124)	0.000182* (9.32E-05)	0.0768 (0.0536)	-0.00095 (0.00071)	-0.00695 (0.0121)	0.000237 (0.00017)
Probability of Cognitive Disability	0.00746 (0.0265)	-4.47E-06 (0.0002)	0.0987 (0.0676)	-0.00126 (0.00088)	0.00801 (0.0145)	-4.17E-05 (0.00011)
Probability of Physical Disability	0.0377* (0.0226)	-0.0002 (0.00018)	0.0132 (0.0676)	-2.57E-05 (0.00093)	0.0404*** (0.0138)	-0.00041** (0.00017)
Probability of Vision & Hearing Difficulty	-0.0178 (0.0289)	0.000125 (0.00022)	0.135* (0.0721)	-0.00191** (0.00096)	-0.006 (0.0195)	7.35E-05 (0.00024)
Probability of Self- Care & Independent Mobility Difficulty	0.0205 (0.014)	-0.00014 (0.00011)	0.0631** (0.0256)	-0.000877** (0.00035)	0.00803 (0.0059)	-6.98E-05 (7.79E-05)

*** p<0.01, ** p<0.05, * p<0.1; Note: Tables report $treated_b$*$erosion_s$ coefficients (main effect) and $interaction$*$treated_b$*$erosion_s$ coefficients (interaction effect) for specifications that interact the baseline treatment term with the relevant measure of the state's total per capita New Deal and related spending. All regressions are estimated by OLS and include two-way interactions and controls for race; birth year, birth state, and census year fixed effects; and state trends. Standard errors, clustered by birth state and birth year, are reported in parentheses below each coefficient. Public spending variables are continuous; to aid in interpreting the interaction coefficient for these regressions, the minimum, maximum, and standard deviation for the relevant variables in the full sample are as follows: New Deal (104.351, 289.141, 47.396); Relief (41.708, 128.980, 23.143); Loans (58.462, 167.357, 23.787).

Table 7 — Impact of Exposure to the Dust Bowl by Mechanism: Public Spending - Women

	New Deal * Erosion (1)		Relief * Erosion (2)		Loans * Erosion (3)	
	Main	Interaction	Main	Interaction	Main	Interaction
Age at First Marriage	0.463**	-0.00360*	-2.671***	0.0368***	0.197	-0.00337
	(0.223)	(0.00199)	(0.696)	(0.00965)	(0.273)	(0.00248)
Children Ever Born	0.0257	-0.00164	1.006*	-0.0169*	-0.203	0.000781
	(0.459)	(0.00342)	(0.599)	(0.00916)	(0.333)	(0.00295)
Probability of Completing High School	-0.0594	0.000688**	0.513***	-0.00662***	-0.0623*	0.00139***
	(0.0397)	(0.00035)	(0.12)	(0.00158)	(0.0327)	(0.00038)
Probability of Completing College	-0.0276	0.00011	-0.08	0.000948	-0.0335**	0.000293
	(0.0304)	(0.00023)	(0.0608)	(0.0008)	(0.0158)	(0.00019)
Welfare Income	-23.97	0.305	-12.93	0.404	-9.507	0.378*
	(38.33)	(0.235)	(135.7)	(1.726)	(17.28)	(0.198)
Probability of Poverty	0.00668	-9.60E-06	-0.00347	9.64E-05	0.0162*	-0.00015
	(0.021)	(0.00017)	(0.0538)	(0.00073)	(0.00857)	(0.00011)
Probability of Cognitive Disability	-0.00597	1.57E-05	0.129**	-0.00186**	-0.015	0.000198
	(0.023)	(0.00018)	(0.0586)	(0.00083)	(0.0176)	(0.00021)
Probability of Physical Disability	0.00364	-5.56E-05	-0.278***	0.00379***	0.0363	-0.00059
	(0.0165)	(0.00017)	(0.104)	(0.00146)	(0.0328)	(0.00042)
Probability of Vision & Hearing Difficulty	-0.0387*	0.000266	0.0388	-0.00055	-0.0134*	0.000208
	(0.0221)	(0.00017)	(0.0517)	(0.00066)	(0.00693)	(0.00013)
Probability of Self- Care & Independent Mobility Difficulty Difficulty	-0.0232*	0.000166	-0.0293	0.000377	-0.00028	2.36E-05
	(0.0133)	(0.0001)	(0.0629)	(0.00084)	(0.00836)	(0.00012)

*** p<0.01, ** p<0.05, * p<0.1; Note: Tables report $treated_b$*$erosion_s$ coefficients (main effect) and *interaction*$treated_b$*$erosion_s$ coefficients (interaction effect) for specifications that interact the baseline treatment term with the relevant measure of the state's total per capita New Deal and related spending. All regressions are estimated by OLS and include two-way interactions and controls for race; birth year, birth state, and census year fixed effects; and state trends. Standard errors, clustered by birth state and birth year, are reported in parentheses below each coefficient. Public spending variables are continuous; to aid in interpreting the interaction coefficient for these regressions, the minimum, maximum, and standard deviation for the relevant variables in the full sample are as follows: New Deal (104.351, 289.141, 47.396); Relief (41.708, 128.980, 23.143); Loans (58.462, 167.357, 23.787).

Figures 1a-1d— Dust Bowl Severity

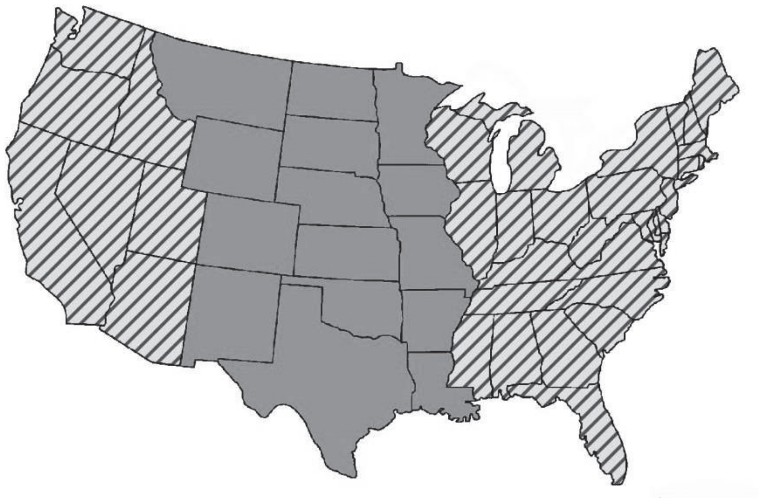


Figure 1a: Sample coverage

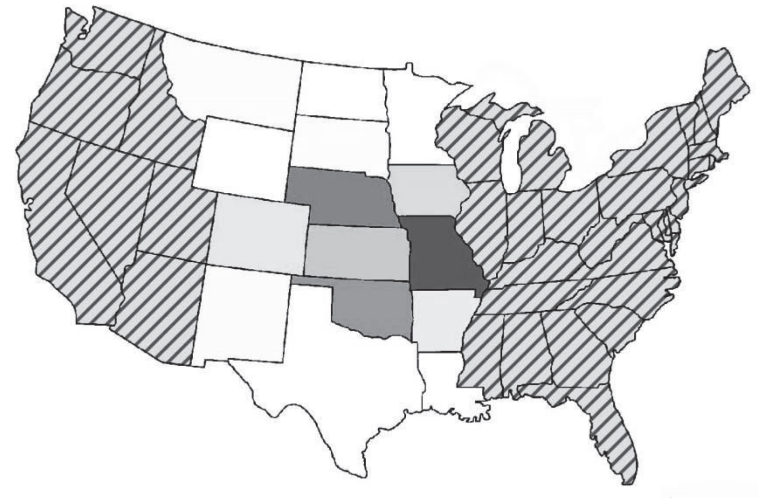


Figure 1b: Proportion of state population living in high erosion areas

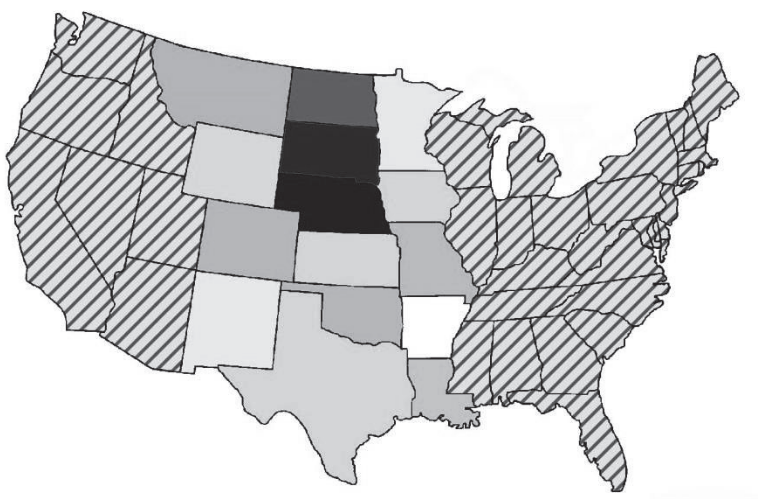


Figure 1c: Proportion of state population living in high farm value loss areas

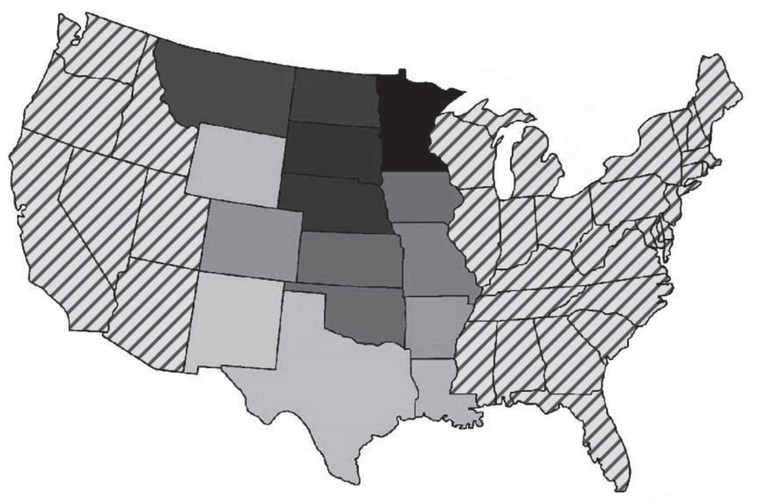


Figure 1d: Sum of magnitudes of drought events between 1930 and 1940

WEB APPENDIX

(Intended for online publication only)

1. METHODOLOGY APPENDIX

Methodology: Eventual Migration

I use the data from my baseline analysis to test whether eventual migrants exposed to the Dust Bowl (that is, individuals found in adulthood to be living in a state other than their birth state; see Data Appendix for a discussion of this variable and its interpretation) have statistically significantly different later-life outcomes than their exposed counterparts enumerated as adults in their birth state. I also test for the effect of Dust Bowl exposure on the likelihood of being such an eventual migrant.

To test for differences in adult outcomes by migrant status, I estimate the following regression, by OLS:

$$h_i = \alpha + \beta_1 \times \text{treated}_t \times \text{erosion}_s + \beta_2 \times \text{migrant}_i \times \text{treated}_t \times \text{erosion}_s + \beta_3 \times \text{migrant}_i \times \text{treated}_b + \beta_4 \times \text{migrant}_i \times \text{erosion}_s + \beta_5 \times \text{migrant}_i + x_i'\psi + \theta_s + \lambda_b + \eta_t + \gamma_s + u_i \quad \text{(WA1)}$$

where h_i , as in the baseline equation (1), is the individual-level human capital outcome of interest for the individual *i* born in year *b* in state *s* and enumerated in year *t*.

$Treated_t$ is a binary dummy which takes the value of 1 if the individual was born between 1918 and 1941, inclusive.

$Erosion_s$ is, as in the baseline regressions, a population-weighted measure of erosion severity in the individual's birth state.

$Migrant_i$ is a binary dummy that takes the value of 1 if the individual is enumerated (as an adult) in a state other than their birth state.

x_i represents a vector of controls, including race.

θ_s, λ_b, and η_t represent census state fixed effects, birth year fixed effects, and census year fixed effects, while γ_s represents state trends. Standard errors are clustered at the birth state and birth year levels.

Each equation is estimated separately for men and women.

I also estimate the effect of Dust Bowl exposure on the likelihood of being a migrant, by OLS:

$$\text{migrant}_i = \alpha + \beta_1 \times \text{treated}_b \times \text{erosion}_s + x_i'\psi + \theta_s + \lambda_b + \eta_t + \gamma_s + u_i \quad \text{(WA2)}$$

All details of this regression are as specified for (WA1) above.

Results are reported in Section 3 of the Web Appendix.

Methodology: Childhood Migration by Household Characteristics

I use data on children (that is, individuals aged 12 and under only) born in my 15 states of interest in the 1% IPUMS samples of the 1920, 1930, 1940, and 1950 US Censuses (Ruggles et al. 2010) to test for whether Dust Bowl exposure and/hour household characteristics influenced a child's likelihood to have migrated before the age of 12. Similar to the method employed in baseline specification (1), I test for whether children born between 1918 and 1941, inclusive (that is, children aged -1 to 12 during the Dust Bowl) were likelier to be enumerated before age 12 in a state other than their birth state. I interact the Dust Bowl treatment term with measures of household income, socioeconomic status, and farm status to test whether certain household characteristics were associated with patterns in who migrated during childhood.

To test for differences in likelihood of having migrated out of the birth state as a child, I estimate the following regression, by OLS:

$$k_{\mathrm{i}} = \alpha + \beta_1 \times \mathrm{treated}_t \times \mathrm{erosion}_s + \beta_2 \times \mathrm{householdcharacteristic}_i \times \mathrm{treated}_t \times \mathrm{erosion}_s + \beta_3 \times \mathrm{householdcharacteristic}_i \times \mathrm{treated}_b + \beta_4 \times \mathrm{householdcharacteristic}_i \times \mathrm{erosion}_s + \beta_5 \times \mathrm{householdcharacteristic}_i + x_i{'}\psi + \theta_s + \lambda_b + \eta_t + \gamma_s + u_i \qquad \text{(WA3)}$$

where k_i is a binary dummy which takes the value of 1 if child i was enumerated in a state other than its birth state.

$Treated_t$ is a binary dummy which takes the value of 1 if the child was born between 1918 and 1941, inclusive.

$Erosion_s$ is, as in the baseline regressions, a population-weighted measure of erosion severity in the child's birth state.

$Householdcharacteristic_i$ is a measure of the child's household income or socioeconomic circumstances; several alternative versions of socioeconomic and household status are used, including Occscore, SEI, PRESGL, and farm status. See Data Appendix for a discussion of these variables. Results are reported in Section 3 of the Web Appendix, with the column headers referring to which of these interacted variables has been used in the specification.

x_i represents a vector of individual- and household-level controls, including sex, race, age, household farm status (for regressions using income variables and where, thus, farm status has not already been included as a control), and income (for regressions using farm status, where income has not already been included as a control) . In regressions on farm status, the income variable control chosen is Occscore.

$\theta_{s,}$, $\lambda_{b,}$ and η_t represent census state fixed effects, birth year fixed effects, and census year fixed effects, while γ_s represents state trends. Standard errors are clustered at the birth state and birth year levels.

The specification above is also estimated and reported in the table under the header of "Dust Bowl" as follows:

$$k_\mathrm{i} = \alpha + \beta_1 \times \mathrm{treated}_t \times \mathrm{erosion}_s + x_i'\psi + \theta_s + \lambda_b + \eta_t + \gamma_s + u_i \qquad \text{(WA4)}$$

As above for farm status regressions, here, Occscore is the income control used.

Results are reported in Section 3 of the Web Appendix.

Methodology: Fertility by Maternal Characteristics

I use data on ever-married women enumerated in my 15 states of interest in the 1% IPUMS samples of the 1920, 1930, 1940, and 1950 US Censuses (Ruggles et al. 2010) to test for fertility selection into my sample. Similar to the method employed in baseline specification (1), I test for whether ever-married women enumerated in 1940 had a lower probability of having had children in the preceding 10 years (that is, that women in 1940, for whom the preceding 10 years coincided with the Dust Bowl period), than those ever-married women for whom the past 10 years were not spend in the Dust Bowl. I interact the Dust Bowl treatment term with measures of household income, socioeconomic status, and farm status to test whether certain maternal characteristics were associated with changes in childbearing patterns.

To test for differences in likelihood of having borne children in the past 10 years across time, I estimate the following regression, by OLS:

$$p_\mathrm{i} = \alpha + \beta_1 \times \mathrm{treated}_t \times \mathrm{erosion}_s + \beta_2 \times \mathrm{householdcharacteristic}_i \times \mathrm{treated}_t \times \mathrm{erosion}_s + \beta_3 \times \mathrm{householdcharacteristic}_i \times \mathrm{treated}_b + \beta_4 \times \mathrm{householdcharacteristic}_i \times \mathrm{erosion}_s + \beta_5 \times \mathrm{householdcharacteristic}_i + x_i'\psi + \theta_s + \lambda_b + \eta_t + \gamma_s + u_i \qquad \text{(WA5)}$$

where p_i is a binary dummy which takes the value of 1 if woman i reported having any children aged 10 or under.

$Treated_t$ is a binary dummy which takes the value of 1 if the census year is 1940.

$Erosion_s$ is, as in the baseline regressions, a population-weighted measure of erosion severity in the state in which the woman is enumerated.

$Householdcharacteristic_i$ is a measure of the woman's household income or socioeconomic circumstances; several alternative versions of socioeconomic and household status are used, including Occscore, SEI, PRESGL, and farm status. See Data Appendix for a discussion of these variables. Results are reported in Section 3 of the Web Appendix, with the column headers referring to which of these interacted variables has been used in the specification.

x_i represents a vector of individual- and household-level controls, including race, age, household farm status (for regressions using income variables and where, thus, farm status has not already been included as a control), and income (for regressions using farm status, where income has not already been included as a control) . In regressions on farm status, the income variable control chosen is Occscore.

$\theta_{s,}$, $\lambda_{b,}$ and η_t represent census state fixed effects, birth year fixed effects, and census year fixed effects, while γ_s represents state trends. Standard errors are clustered at the census state and birth year levels.

Results are reported in Section 3 of the Web Appendix.

Methodology: Birth Rates

I use yearly state-level crude birth rates over the period 1915-1960 from US Vital Statistics (Public Health Service 1947; National Center for Health Statistics 1968) for each of the 15 states in my sample to test for whether the Dust Bowl cohort had significantly different (for instance, lower) birth rates than those not exposed.

To test for differences in birth rates across cohorts, I estimate the following regression, by OLS:

$$c_{st} = \alpha + \beta_1 \times \text{treated}_t \times \text{erosion}_s + \theta_s + \lambda_t + \gamma_s + u_{st} \quad \text{(WA6)}$$

where c_{st} is the crude birth rate in state *s* in year *t.*

$Treated_t$ is a binary dummy which takes the value of 1 if the year is 1930-40, inclusive. In order to test when birth rates may have begun to respond to Dust Bowl conditions, treated_t is also alternatively defined as 1 if the year is 1931-40, 1932-40, and on until treated_t takes the value of 1 only if the year is 1940; results for each of these definitions of treated_t are reported in Section 3 of the Web Appendix under column headers referring to how treated_t has been defined in that specification.

$Erosion_s$ is, as in the baseline regressions, a population-weighted measure of erosion severity in state *s*.

As in the baseline, $\theta_{s,}$ and λ_t represent state fixed effects and year fixed effects, while γ_s represents state trends. Standard errors are clustered at the state level.

Results are reported in Section 3 of the Web Appendix.

Methodology: Stillbirths

I use yearly state-level stillbirth rates over the period 1915-1960 from US Vital Statistics (Public Health Service 1947; National Center for Health Statistics 1968) for each of the 15 states in my sample to test for whether the Dust Bowl cohort had significantly higher stillbirth rates than those not exposed.

To test for differences in stillbirth rates across cohorts, I estimate the following regression, by OLS:

$$b_{st} = \alpha + \beta_1 \times \text{treated}_t \times \text{erosion}_s + \theta_s + \lambda_t + \gamma_s + u_{st} \qquad \text{(WA7)}$$

where b_{st} is the stillbirth rate in state s in year t.

Treated$_t$ is a binary dummy which takes the value of 1 if the year is 1930-40, inclusive. In order to test when stillbirth rates may have begun to respond to Dust Bowl conditions, *treated*$_t$ is also alternatively defined as 1 if the year is 1931-40, 1932-40, and on until *treated*$_t$ takes the value of 1 only if the year is 1940; results for each of these definitions of *treated*$_t$ are reported in Section 3 of the Web Appendix under column headers referring to how *treated*$_t$ has been defined in that specification.

Erosion$_s$ is, as in the baseline regressions, a population-weighted measure of erosion severity in state s.

As in the baseline, $\theta_{s,}$ and λ_t represent state fixed effects and year fixed effects, while γ_s represents state trends. Standard errors are clustered at the state level.

Results are reported in Section 3 of the Web Appendix.

Methodology: Infant Mortality

I use yearly state-level infant mortality rates over the period 1915-1960 from US Vital Statistics (Public Health Service 1947; National Center for Health Statistics 1968) for each of the 15 states in my sample to test for whether the Dust Bowl cohort had significantly higher infant mortality rates than those not exposed.

To test for differences in infant mortality rates across cohorts, I estimate the following regression, by OLS:

$$i_{st} = \alpha + \beta_1 \times \text{treated}_t \times \text{erosion}_s + \theta_s + \lambda_t + \gamma_s + u_{st} \quad \text{(WA8)}$$

where i_{st} is the infant mortality rate in state s in year t.

$Treated_t$ is a binary dummy which takes the value of 1 if the year is 1930-40, inclusive. In order to test when infant mortality rates may have begun to respond to Dust Bowl conditions, $treated_t$ is also alternatively defined as 1 if the year is 1931-40, 1932-40, and on until $treated_t$ takes the value of 1 only if the year is 1940; results for each of these definitions of $treated_t$ are reported in Section 3 of the Web Appendix under column headers referring to how $treated_t$ has been defined in that specification.

$Erosion_s$ is, as in the baseline regressions, a population-weighted measure of erosion severity in state s.

As in the baseline, θ_s, and λ_t represent state fixed effects and year fixed effects, while γ_s represents state trends. Standard errors are clustered at the state level.

Results are reported in Section 3 of the Web Appendix.

Methodology: Mortality Across Life-Course

I use decadal state-level mortality rates from US Vital Statistics 1930-2000 (Public Health Service 1947; National Center for Health Statistics 1968, 1974, 1985, & 1994; Centers for Disease Control and Prevention 2000, 2003, & 2013; National Bureau of Economic Research 2006) for each of the 15 states in my sample to test for whether the Dust Bowl cohort had significantly higher mortality rates at any life stage (under age 1, 1-4, 5-14, 15-24, 25-34, 45-54, 55-64, 65-74, and 74-85) up to and including my observation period, than those not exposed.

To test for differences in age-specific mortality rates, I estimate the following regression, by OLS:

$$m_{gast} = \alpha + \beta_1 \times \text{treated}_t \times \text{erosion}_s + \theta_s + \lambda_t + \gamma_s + u_{gast} \quad \text{(WA9)}$$

where m_{gast} is the mortality rate for gender g in age bin a in state s in year t.

$Treated_t$ is a binary dummy which takes the value of 1 if in a given census year, the age bin for which the regression is being run is populated only by individuals who were aged -1 to

12 during the Dust Bowl (that is, the age bin contains only 1918-41 births in the given census year). Regressions using this version of $treated_t$ are referred to in the tables as "age bins narrowly defined" since an age bin only counts as containing the Dust Bowl cohort if all the age bins members were children during the Dust Bowl. In the specifications labeled "age bins broadly defined", $treated_t$ takes the value of 1 if any individual in that age bin was a child during the Dust Bowl, even if the age bin also contains individuals not exposed to the Dust Bowl as children. For instance, an age bin containing people born 1915-1920 would be categorized as broadly rather than narrowly defined $treated_t$, since it contains people born 1918-1920, who belong to the Dust Bowl cohort, but also contains people born 1915-1917 who were not part of the Dust Bowl cohort.

$Erosion_s$ is, as in the baseline regressions, a population-weighted measure of erosion severity in state *s*.

As in the baseline, θ_s, and λ_t represent state fixed effects and year fixed effects, while γ_s represents state trends. Standard errors are clustered at the state level.

The regression is estimated separately for each gender and age bin; results are reported in Section 3 of the Web Appendix.

2. DATA APPENDIX

Outcome Variables

As discussed in Section 2.1, all data on adult outcomes are taken from the 5% samples of the 1980, 1990, and 2000 US Censuses, available through IPUMS (Ruggles et al. 2010). The sample is restricted to individuals born between the years 1900 and 1959, inclusive, in the 15 Great Plains and adjacent states: Arkansas, Colorado, Iowa, Kansas, Louisiana, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming.

Individual-level outcomes are as follows:

Age at First Marriage — The individual's age at first marriage ("AGEMARR" in IPUMS). Regressions on age at marriage are restricted to only those individuals who have been married at least once, and for whom age at marriage is known.

Children Ever Born — The total number of children born to the individual, excluding stillbirths, adopted children, and stepchildren (reported only for female respondents in the census; "CHBORN" in IPUMS). IPUMS "Not applicable" values have been excluded, and regressions on children ever born are restricted to women where the number of children born is known.

Probability of Completing High School — 1 if the individual completed high school, and 0 if not (Constructed based on "HIGRADE" in IPUMS, such that individuals with 13 or more years of schooling [HIGRADE ≥ 15] are deemed to have completed high school).

Probability of Completing College — 1 if the individual completed college, and 0 if not (Constructed based on "HIGRADE" in IPUMS, such that individuals with 17 or more years of schooling [HIGRADE ≥ 19] are deemed to have completed college).

Welfare Income — The contemporary dollar amount of pre-tax income, if any, the individual received through public assistance programs including federal/state Supplemental Security Income, Aid to Families with Dependent Children, and General Assistance, but excluding private charitable sources of income ("INCWELFR" in IPUMS).

Probability of Poverty — 1 if the individual is living at or below the official federal poverty threshold designated for their household size and structure, and 0 if not (Constructed based on "POVERTY" in IPUMS, such that individuals for whom POVERTY ≤ 100 are deemed to be living in poverty).

Probability of Cognitive Disability — 1 if the individual has cognitive difficulties such as those involved in learning, decision-making, concentrating, or remembering; and 0 if not (Constructed based on "DIFFREM" in IPUMS such that individuals experiencing any sort of cognitive impairment are deemed to suffer from cognitive disability).

Probability of Physical Disability — 1 if the individual suffers from conditions that significantly limits one or more essential day-to-day physical activities, such as walking, lifting, climbing, etc.; and 0 if not (Constructed based on "DIFFPHYS" in IPUMS such that individuals experiencing any sort of ambulatory difficulty are deemed to suffer from physical disability).

Probability of Vision & Hearing Difficulty — 1 if the individual has long-lasting blindness, deafness, or other severe vision or hearing difficulty; and 0 if not (Constructed based on "DIFFSENS" in IPUMS such that individuals experiencing any sort of vision or hearing impairment are deemed to suffer from cognitive disability).

Probability of Self-Care & Independent Mobility Difficulty — 1 if the individual has lasting (i.e. non-temporary) conditions that cause difficulty in performing basic personal activities either within or outside the home (e.g. bathing, dressing, shopping, visiting the doctor); and 0 if not (Constructed based on "DIFFCARE" and "DIFFMOB" in IPUMS such that individuals experiencing any sort of impairment in either variable are deemed to suffer from self-care and independent mobility difficulty).

Dust Bowl Exposure Variables

Erosion — The proportion of the state population in 1930 living in high-erosion counties in the individual's birth state (constructed using 1930 county population figures and county-level erosion classifications from the U.S. Census) (Hornbeck 2012b). This variable may be interpreted as the probability that an individual in a given state experienced high erosion. Census data, through which only birth state, rather than birth county or birth city is known, does not allow me to pinpoint the actual Dust Bowl severity experienced by an individual in childhood. I attempt to overcome these limitations by constructing this variable such that it accounts for the distribution of population over space. By incorporating county-level information on human geography, I arrive at a measure of Dust Bowl severity more appropriate to a study of the human costs of the disaster than those not "weighted" by population, such as those weighted by county area.

Change in Farm Values — The proportion of the state population in 1930 living in high-farm value-loss counties in the individual's birth state (constructed using 1930 county population figures and 1930 and 1940 county-level farm values from the U.S. Census of Agriculture; Hornbeck 2012b). To construct this figure, I calculate for each county the percentage change in farm values over the Dust Bowl period, that is, between 1930 and 1940. I then classify the tercile of counties in my sample that experienced the greatest drop in farm values over the period as experiencing "high" farm value loss. I then calculate the proportion of the 1930 population in each state living in high farm value loss counties. By accounting for farm values prior to the Dust Bowl, this variable overcomes the weaknesses in erosion data, for which pre-Dust Bowl baselines do not exist (Soil Conservation Service 1935; Hornbeck 2012a). Furthermore, farm values may capture Dust Bowl effects—for instance, economic ones—that erosion alone does not.

Drought — The sum of drought magnitudes for all official drought events occurring between 1930 and 1940 in the individual's birth state. Drought figures are calculated using monthly climate station-level NOAA data on historical rainfall collected from 1910 to 2010 (National Climatic Data Center of the National Oceanic and Atmospheric Administration 2013); the 100-year span of data used exceeds the minimum roughly 50-year sample recommended to establish state baselines (McKee et al. 1993; Wu et al. 2004). Since not all states had climate stations in every county in the early- to mid-20th Century, it is not possible to gather county-level drought data nor is it possible to weight drought by county-level population as in the erosion and farm value measures of Dust Bowl severity. Instead, I summed the precipitation levels of each climate station within a state in a given month and divided it by the number of climate stations in that state in that month to create monthly state-level precipitation averages. To normalize the rainfall data to allow comparability both across states and across time within a state, these raw precipitation figures were converted to a monthly Standardized Precipitation Index (SPI) figure using a 12-month timescale to capture both short- and longer-term drought effects. The SPI method is preferred by climatologists to other common drought indices, such as the Palmer Drought Index, because of its simplicity and its incorporation of climatological timescales (McKee et al. 1993; Guttman 1999; Wu et al. 2004; World Meteorological Organization 2009). Per McKee et al. (1993), the monthly state-level SPI figures were used to identify official drought events (McKee et al. 1993), and the magnitudes of these events (which capture both severity and duration of drought) were summed over the 1930 to 1940 period to create a single state-level variable representing the total severity of drought in a state during the Dust Bowl timeframe, relative to the state's own historic rainfall baseline.

Treated (Baseline) — 1 if the individual was aged -1 to 12 at any point during the Dust Bowl period of 1930 to 1940, and 0 if not. This age span represents childhood, here defined as the time *in utero* to the onset of puberty. This variable denotes whether an individual was a child during the Dust Bowl, and thus may plausibly have been exposed to Dust Bowl shocks such as dust storms.

Treated (Developmental Stage) — The proportion of the given age range (-1 to 0, 1 to 3, 4 to 6, 7 to 9, and 10 to 12) spent in (i.e., that coincides with) the Dust Bowl period of 1930 to 1940. For example, an individual born in 1941 spent 50% of the -1 to 0 age range in the Dust Bowl, while an individual born in 1940 spent 100% of the same age range in the Dust Bowl, and an individual born in 1942 spent 0% of this age range in the Dust Bowl. Similarly, an individual born in 1919 would have spent 66.7% of the 10 to 12 age range but 0% of the 7 to 9 age range in the Dust Bowl timeframe. This variable is thus a measure of the developmental stage or age at plausible exposure to the Dust Bowl, weighted more heavily for those that spent a greater proportion of the developmental stage during the Dust Bowl period.

Individual & Household Characteristics

Sex — 1 if the individual is female, 0 if male.

Race — 1 if the individual is non-white, 0 if white. (Constructed based on "RACE" in IPUMS such that all individuals not identifying exclusively as "white" are deemed non-white).

Veteran Status — 1 if the individual has ever served in the US armed forces on active duty, 0 if not (Constructed based on "VETSTAT" in IPUMS such that only individuals explicitly listed as veterans are deemed veterans; those where veteran status is unknown are counted as non-veterans). For all the census waves used in this study, women are included in this definition of military service.

Migrant Status (Adult) — 1 if the individual is living in a state other than the birth state at the time of the census, 0 if not (Constructed based on "BPL" and "STATEFIP" in IPUMS such that individuals for whom BPL ≠ STATEFIP are deemed migrants.) Although the age at which migration took place is unknown, and although it is possible that even those who are currently found living in their birth state migrated out at some point before returning, this variable serves as a rough proxy for individuals who may have migrated out of the sample during childhood.

Migrant Status (Child) — 1 if the individual, currently (in the 1920-50 Censuses) aged 12 or below, is living in a state other than the birth state at the time of the census, 0 if not (Constructed based on "BPL" and "STATEFIP" in IPUMS such that individuals for whom BPL ≠ STATEFIP are deemed migrants.) This allows for testing the impact of dust on children's likelihood of migration, as well as that of household characteristics on determining who may have migrated out of the sample during childhood.

Income in Childhood — per capita personal income in the birth year and birth state (Income in Birth Year), per capita personal income in birth state and year before birth (Income *In Utero*), or per capita personal income in the birth state averaged across the years in which the child was aged -1 to 12, inclusive (Average Income Across Childhood). Income figures are all in 1982-4 dollars (Sahr 2007). Yearly per capita personal income by state is taken from the Bureau of Economic Analysis (2012) for 1929 to 1971; from Easterlin (1957) for 1920; from Klein (2009) for 1890, 1900, and 1910; and is exponentially interpolated from the known data for 1899, 1901-9, 1911-9, and 1921-8.

Occscore — A continuous variable proxying household income before income was recorded in the Census, constructed by IPUMS (Ruggles et al. 2010) as the median salary attached to the household head's stated occupation. (The variables SEI and PRESGL are also used to proxy for household income and socioeconomic status; see IPUMS for further details of these variables' construction.)

Farm — In regressions using the 1920-50 Censuses (Ruggles et al. 2010), 1 if the household is listed as a farm household in the Census, i.e. the household is engaged in agricultural occupations; and 0 if not.

Fixed Effects & Trends

Birth State — The individual's state of birth (identified using "BPL" in IPUMS). Note that in censuses from 1940 onwards, no detail below birth state (such as birth county) is available. In this paper, only those born in Arkansas, Colorado, Iowa, Kansas, Louisiana, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming are included in the sample. These states are selected for being states in the Great Plains region or states neighboring the Great Plains. Studies using Dust Bowl erosion to explain agricultural and environmental phenomena have used a similar if slightly smaller set of states (Hansen & Libecap 2004; Hornbeck 2012a); my sample adds states like Missouri and Arkansas that the qualitative literature suggests may have also suffered from the Dust Bowl (Nealand 2008). The use of states beyond those strictly in the Great Plains/those hardest hit by the Dust Bowl allows me to exploit a greater degree of variation in shock severity. Such variation is necessary for differences-in-differences analysis.

Birth Year — The individual's year of birth (identified using "BIRTHYR" in IPUMS). In this paper, only those born in the years 1900 to 1959, inclusive, are included in the sample. Since individuals born between 1918 and 1941, inclusive, are the cohort of interest, the inclusion of individuals born before and after this period allows for differences-in-differences estimation against those who could not possibly have been exposed to the Dust Bowl.

Census Year — The census year in which the individual's data is reported (identified using "YEAR" in IPUMS). In this paper, the 5% sample of the US census for 1980, 1990, and 2000 are used. These census waves are chosen in part for the specific variables they report which other censuses do not (such as the highest grade achieved, or a standardized veteran status), as well as to enable capture adult outcomes that are relatively stable (such as those for schooling and fertility, which an individual may not yet have completed if using earlier censuses) (Bhalotra & Venkataramani 2012).

State Trends — A linear time trend for each birth state in the sample (constructed using "BPL" and "BIRTHYR" in IPUMS).

Agriculture

Farm Population-Weighted Erosion — replaces erosion_s in equation (1); The proportion of the state's farm population in 1930 living in high-erosion counties in the individual's birth state (constructed using 1930 county farm population figures and county-level erosion classifications from the U.S. Census; Hornbeck 2012b). This variable may be interpreted as the probability that those engaged in agriculture in a given state experienced high erosion, and thus, as a measure of the severity of the Dust Bowl for agriculture-dependent communities.

Farm-Dependence — farm_s in equation (2); 1 if the individual is born into a state where the farm population as a proportion of total population in the individual's birth state is above the sample average, 0 if below average (constructed using 1930 county farm population and general population figures from the U.S. Census; Hornbeck 2012b). This variable is a proxy for the state's dependence on agricultural livelihoods, and is interacted with the baseline equation's standard treated*erosion term to test whether agriculture-dependence changes effect of the Dust Bowl shock. As a measure of farm-dependence, this variable serves as an alternative definition to that used in *Farm Population-Weighted Erosion.*

Public Spending

New Deal — total per capita New Deal expenditure in the individual's birth state; for further detail, see Fishback et al. (2003) and http://www.u.arizona.edu/~fishback/ Published_Research_Datasets.html.

Relief — total per capita relief expenditure in the individual's birth state as a part of New Deal and related programs; for further detail, see Fishback et al. (2003) and http://www.u.arizona.edu/~fishback/ Published_Research_Datasets.html.

Loans — total per capita loan expenditure in the individual's birth state as a part of New Deal and related programs; for further detail, see Fishback et al. (2003) and http://www.u.arizona.edu/~fishback/ Published_Research_Datasets.html.

3. TABLE APPENDIX

Table WA1 — Impact of Exposure to the Dust Bowl on Later-life Outcomes: Depression Controls - Men

	Income in Year of Birth		Income *In Utero*		Average Income Across Childhood	
	(1)		(2)		(3)	
	Treated*Erosion	PC Income	Treated*Erosion	PC Income	Treated*Erosion	PC Income
Age at First Marriage	-0.159 (0.1260)	0.000124*** (0.0000)	-0.161 (0.1280)	0.000129*** (0.0000)	-0.154 (0.1250)	0.000337*** (0.0001)
Probability of Completing High School	0.0185 (0.0138)	-7.81E-06 (0.0000)	0.0184 (0.0140)	-6.87E-06 (0.0000)	0.0184 (0.0115)	-3.11e-05*** (0.0000)
Probability of Completing College	-0.0105 (0.0075)	-1.33E-06 (0.0000)	-0.0102 (0.0075)	-2.52E-06 (0.0000)	-0.0107 (0.0071)	-1.18E-06 (0.0000)
Welfare Income	15.92* (8.3350)	-0.00438** (0.0020)	16.29** (8.1360)	-0.00583*** (0.0019)	15.48* (8.3170)	-0.0143*** (0.0055)
Probability of Poverty	0.00898*** (0.0034)	-4.82e-06*** (0.0000)	0.00874** (0.0036)	-3.38e-06* (0.0000)	0.00840** (0.0033)	-1.26e-05*** (0.0000)
Probability of Cognitive Disability	0.00735 (0.0068)	-4.64E-06 (0.0000)	0.00716 (0.0068)	-3.42E-06 (0.0000)	0.00647 (0.0062)	-9.52e-06* (0.0000)
Probability of Physical Disability	0.0116** (0.0050)	-3.75e-06* (0.0000)	0.0112** (0.0049)	-9.96E-07 (0.0000)	0.0109** (0.0046)	-1.47e-05* (0.0000)
Probability of Vision & Hearing Difficulty	-0.00234 (0.0060)	-2.26E-06 (0.0000)	-0.0024 (0.0061)	-1.79E-06 (0.0000)	-0.00279 (0.0057)	-9.04e-06** (0.0000)
Probability of Self- Care & Independent Mobility Difficulty	5.73E-05 (0.0031)	-1.75e-06* (0.0000)	0.000239 (0.0030)	-2.52e-06*** (0.0000)	-0.00021 (0.0033)	-4.57e-06* (0.0000)

*** p<0.01, ** p<0.05, * p<0.1; Note: Table reports, for each regression, the $treated_b$*$erosion_s$ and per capita income coefficients. Column headers refer to the measure of birth state-birth year per capita income used. All regressions are estimated by OLS and include additional controls for race; birth year, birth state, and census state fixed effects; and state trends. Standard errors, clustered by birth state, are reported in parentheses below each coefficient. To aid in interpreting the coefficients of the per capita income variables, the minimum, maximum, and standard deviation are as follows: Income in Year of Birth (988.636, 7842.472, 1686.206); Income *In Utero* (854.516, 7610.116, 1650.102); Average Income Across Childhood (1292.224, 8893.168, 1878.751).

Table WA2 — Impact of Exposure to the Dust Bowl on Later-life Outcomes: Depression Controls - Women

	Income in Year of Birth		Income *In Utero*		Average Income Across Childhood	
	(1)		(2)		(3)	
	Treated*Erosion	PC Income	Treated*Erosion	PC Income	Treated*Erosion	PC Income
Age at First Marriage	-0.0312 (0.1110)	0.000130*** (0.0000)	-0.034 (0.1120)	0.000140*** (0.0000)	-0.0159 (0.1120)	0.000191*** (0.0001)
Children Ever Born	-0.196 (0.1360)	-5.15E-05 (0.0000)	-0.195 (0.1340)	-5.22e-05* (0.0000)	-0.201 (0.1400)	-0.0001 (0.0001)
Probability of Completing High School	0.0324* (0.0178)	-8.50E-06 (0.0000)	0.0326* (0.0176)	-8.90e-06* (0.0000)	0.0330** (0.0158)	-4.08e-05*** (0.0000)
Probability of Completing College	-0.0132*** (0.0050)	7.48e-06*** (0.0000)	-0.0133** (0.0052)	7.55e-06*** (0.0000)	-0.0124*** (0.0046)	1.36e-05* (0.0000)
Welfare Income	17.18** (8.4190)	-0.00323 (0.0027)	17.09** (8.3850)	-0.00262 (0.0033)	17.48** (8.3410)	-0.0223*** (0.0071)
Probability of Poverty	0.00552* (0.0028)	-4.32e-06** (0.0000)	0.00573** (0.0029)	-5.07e-06** (0.0000)	0.00478* (0.0025)	-2.96E-06 (0.0000)
Probability of Cognitive Disability	-0.00484 (0.0062)	-2.83E-06 (0.0000)	-0.00431 (0.0060)	-5.24e-06** (0.0000)	-0.00534 (0.0064)	-3.47E-06 (0.0000)
Probability of Physical Disability	-0.00269 (0.0112)	3.06E-06 (0.0000)	-0.00347 (0.0108)	6.68e-06*** (0.0000)	-0.00219 (0.0112)	7.30E-06 (0.0000)
Probability of Vision & Hearing Difficulty	-0.00249 (0.0056)	1.11E-06 (0.0000)	-0.00249 (0.0057)	1.06E-06 (0.0000)	-0.00236 (0.0054)	7.03E-06 (0.0000)
Probability of Self- Care & Independent Mobility Difficulty	-0.00132 (0.0031)	-7.33E-07 (0.0000)	-0.00106 (0.0030)	-1.87E-06 (0.0000)	-0.00139 (0.0030)	-2.18E-06 (0.0000)

*** p<0.01, ** p<0.05, * p<0.1; Note: Table reports, for each regression, the $treated_b*erosion_s$ and per capita income coefficients. Column headers refer to the measure of birth state-birth year per capita income used. All regressions are estimated by OLS and include additional controls for race; birth year, birth state, and census state fixed effects; and state trends. Standard errors, clustered by birth state, are reported in parentheses below each coefficient. To aid in interpreting the coefficients of the per capita income variables, the minimum, maximum, and standard deviation are as follows: Income in Year of Birth (988.636, 7842.472, 1677.844); Income *In Utero* (854.516, 7610.116, 1640.673); Average Income Across Childhood (1292.224, 8893.168, 1883.209).

Table WA3 — Impact of Exposure to the Dust Bowl on Later-life Outcomes: Migration Analysis on Adults

	Dust Bowl	Migrant * Erosion		Migrant	Migrant * Erosion	
	(1)	(2)		(3)	(4)	
	Men			Women		
		Main	Interaction		Main	Interaction
Probability of (Eventual) Migration	0.016 (0.0288)			0.0194 (0.0292)		
Age at First Marriage		-0.0688 (0.1470)	-0.0894 (0.0649)		0.106 (0.1230)	-0.229** (0.0944)
Children Ever Born					-0.243 (0.1650)	0.087 (0.1020)
Probability of Completing High School		0.0113 (0.0178)	-0.00178 (0.0108)		0.0425* (0.0221)	-0.0373
Probability of Completing College		-0.0253** (0.0114)	0.0179 (0.0141)		-0.0119*** (0.0011)	-0.00232
Welfare Income		22.72** (9.3270)	-17.62		21.22 (13.2600)	-8.97 (16.1000)
Probability of Poverty		0.00811*** (0.0029)	0.00675		0.00502	0.00159 (0.0046)
Probability of Cognitive Disability		0.00531 (0.0074)	0.00379 (0.0043)		0.00098 (0.0052)	-0.0143*** (0.0007)
Probability of Physical Disability		0.0124*** (0.0038)	-0.00179 (0.0041)		-0.00295 (0.0141)	0.00189 (0.0114)
Probability of Vision & Hearing Difficulty		-0.00126 (0.0066)	-0.00391 (0.0078)		0.00361 (0.0047)	-0.0125** (0.0058)
Probability of Self- Care & Independent Mobility Difficulty		0.00265 (0.0060)	-0.00538 (0.0082)		0.00479** (0.0019)	-0.0129** (0.0057)

*** p<0.01, ** p<0.05, * p<0.1; Note: Columns 1 & 4 report *treated*$_b$**erosion*$_s$ coefficients. Columns 2 & 4 report treated$_b$*erosion$_s$ coefficients (main effect; i.e., that for Dust Bowl-exposed non-migrants) and *migrant*$_i$**treated*$_b$**erosion*$_s$ coefficients (interaction effect; i.e., that for Dust Bowl-exposed eventual migrants) for specifications that interact the baseline treatment term with the individual's lifetime migrant status. All regressions are estimated by OLS and include two-way interactions and controls for race; birth year, birth state, and census state fixed effects; and state trends. Standard errors, clustered by birth state and birth year, are reported in parentheses below each coefficient.

Table WA4 — Impact of Household Status on Decision to Migrate During the Dust Bowl: Migration Analysis on Children

	Dust Bowl	Occscore * Erosion		SEI * Erosion		PRESGL * Erosion		Farm * Erosion		Farm * Erosion	
	(1)	(2)		(3)		(4)		(5)		(6)	
		Main	Interaction	Main	Interaction	Main	Interaction	Main	Interaction	Main	Interaction
Prob. of (Childhood) Migration	-0.144*	-0.178	-0.015	-0.195	-0.00454	-0.249	-0.00363	-0.0242	0.021	0.432**	-0.617***
	(0.0857)				(0.00951)		(0.00768)	(0.018)	(0.0189)	(0.184)	(0.135)

*** p<0.01, ** p<0.05, * p<0.1; Note: Column 1 reports the $treated_b$*$erosion_s$ coefficient. Columns 2-6 report $treated_b$*$erosion_s$ coefficients (main effect) and *interaction*$treated_b$*$erosion_s$ coefficients (interaction effect) for specifications that interact the baseline treatment term with the child's household income/socioeconomic status measure. All regressions are estimated by OLS and include two-way interactions and controls for race, age, sex, farm status, and household income; birth state, birth year, and census year fixed effects; and state trends. Standard errors, clustered by birth state and birth year, are reported in parentheses below each coefficient. Farm status is a binary variable, while the other household status terms are continuous; to aid in interpreting the interaction coefficient for the remaining household status variables, the minimum, maximum, and standard deviation are as follows: Occscore (3, 80, 6.060); SEI (6, 92, 7.494); PRESGL (14.7, 81.5, 6.507).

Table WA5 — Impact of Household Status on Decision to Bear Children During the Dust Bowl

	Occscore * Erosion (1)		SEI * Erosion (2)		PRESGL * Erosion (3)		Farm * Erosion (4)	
	Main	Interaction	Main	Interaction	Main	Interaction	Main	Interaction
Probability of Having Had a Child in the Past 10 Years	0.0489**	-0.00069	0.0356	0.000197	0.036	0.000173	0.0454	-0.0109
	(0.0221)	(0.0008)	(0.0261)	(0.0003)	(0.0447)	(0.0010)		(0.0411)

*** p<0.01, ** p<0.05, * p<0.1; Note: Table reports $treated_b$*$erosion_s$ coefficients (main effect) and *interaction**$treated_b$*$erosion_s$ coefficients (interaction effect) for specifications that interact the baseline treatment term with the woman's household income/socioeconomic status measure. All regressions are estimated by OLS and include two-way interactions and controls for race, age, household farm status, and income; census state, birth year, and census year fixed effects; and state trends. Standard errors, clustered by census state and birth year, are reported in parentheses below each coefficient. Farm status is a binary variable, while the other household status terms are continuous; to aid in interpreting the interaction coefficient for the remaining household status variables, the minimum, maximum, and standard deviation are as follows: Occscore (3, 80, 10.081); SEI (4, 96, 21.632); PRESGL (9.3, 81.5, 13.327).

Table WA6 — Impact of Dust Bowl Exposure on State Birth, Stillbirth, and Infant Mortality Rates

	1930-40	1931-40	1932-40	1933-40	1934-40	1935-40	1936-40	1937-40	1938-40	1939-40	1940
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(2)
Crude Birth Rate	0.0518	0.0455	0.0415	-0.14	-0.361	-0.53	-0.56	-0.546	-0.536	-0.417	-0.489
	(0.4770)	(0.5430)	(0.6220)	(0.7550)	(0.7450)	(0.7050)	(0.7020)	(0.8570)	(0.9330)	(0.9300)	(1.1290)
Stillbirth Rate	-0.401	-0.134	0.19	0.497	0.944	1.155	0.617	0.853	0.995	0.355	3.198**
	(2.1680)	(2.1540)	(2.2220)	(2.3170)	(2.2360)	(2.1330)	(2.0910)	(1.5110)	(1.4960)	(1.5420)	(1.3750)
Infant Mortality Rate	-0.952	0.43	0.428	-0.0181	0.0726	-1.436	-0.861	-2.095	-2.619	-2.903	-1.155
	(3.0420)	(3.1900)	(3.0220)	(3.0560)	(3.5210)	(3.2890)	(3.1000)	(3.1180)	(3.1670)	(3.2980)	(3.8670)

*** p<0.01, ** p<0.05, * p<0.1; Note: Table reports the $treated_b$*$erosion_s$ coefficient. Column headers refer to the way the $treated_b$ term is defined (e.g. for Column 1, $treated_b$ = 1 if the year is 1930-40, inclusive). All regressions are estimated by OLS and include state and year fixed effects and state trends. Standard errors, clustered by state, are reported in parentheses below each coefficient.

Table WA7 — Impact of Dust Bowl Exposure on Age-Specific Mortality Rates – Men

	Under 1	1-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mortality Rate (Age Bin Narrowly Defined)	-16.67	-0.0812	-0.406**	0.268	0.168	0.2	-0.00796	0.628	-1.009	
	(15.6200)	(1.2540)	(0.1610)	(0.3920)	(0.5370)	(0.3880)	(0.6670)	(0.9980)	(1.2640)	
Mortality Rate (Age Bin Broadly Defined)	-16.67	-0.0812	0.0344	-0.0902	0.325	0.0839	-0.112	-3.212**	-1.719	-6.228
	(15.6200)	(1.2540)	(0.1040)	(0.4540)	(0.6010)	(0.5020)	(0.4400)	(1.1270)	(2.6260)	(4.0260)

*** p<0.01, ** p<0.05, * p<0.1; Note: Table reports the $treated_b*erosion_s$ coefficient, e.g. the effect of Dust Bowl cohort membership on mortality rates within a given age bin, relative to mortality rates in the same age bin for those not exposed to the Dust Bowl. Column headers refer to the age bin for which the regression has been run. Row 1 reports results where $treated_b$ has been narrowly defined, i.e., $treated_b = 1$ only if the age bin contains only Dust Bowl-exposed individuals; Row 2 reports results where $treated_b$ has been broadly defined, i.e., $treated_b = 1$ if the age bin contains any Dust Bowl-exposed individuals. All regressions are estimated by OLS and include state and year fixed effects and state trends. Standard errors, clustered by state, are reported in parentheses below each coefficient.

Table WA8 — Impact of Dust Bowl Exposure on Age-Specific Mortality Rates – Women

	Under 1	1-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mortality Rate (Age Bin Narrowly Defined)	-15.16	-0.883	-0.275	0.17	0.502	0.138	0.144	0.439	0.552	
	(11.3700)	(1.2450)	(0.2020)	(0.4120)	(0.4220)	(0.2720)	(0.3350)	(0.8080)	(1.2880)	
Mortality Rate (Age Bin Broadly Defined)	-15.16	-0.883	-0.0862	0.484	0.542	0.363	0.0564	0.673	0.502	0.984
	(11.3700)	(1.2450)	(0.0757)	(0.4530)	(0.4880)	(0.3850)	(0.3890)	(0.9550)	(1.5320)	(2.2290)

*** p<0.01, ** p<0.05, * p<0.1; Note: Table reports the $treated_b*erosion_s$ coefficient, e.g. the effect of Dust Bowl cohort membership on mortality rates within a given age bin, relative to mortality rates in the same age bin for those not exposed to the Dust Bowl. Column headers refer to the age bin for which the regression has been run. Row 1 reports results where $treated_b$ has been narrowly defined, i.e., $treated_b = 1$ only if the age bin contains only Dust Bowl-exposed individuals; Row 2 reports results where $treated_b$ has been broadly defined, i.e., $treated_b = 1$ if the age bin contains any Dust Bowl-exposed individuals. All regressions are estimated by OLS and include state and year fixed effects and state trends. Standard errors, clustered by state, are reported in parentheses below each coefficient.

4. FIGURE APPENDIX

Figures WA1a-WA1j— Summary Statistics: Average Later-Life Outcomes by Birth Year and Sex

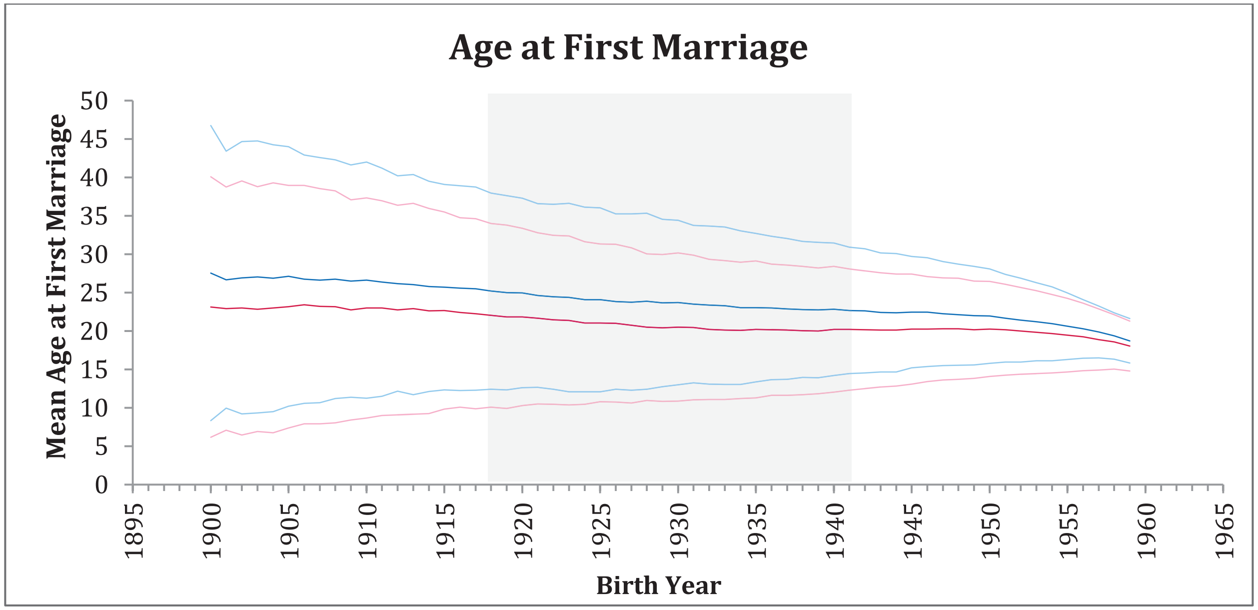


Figure WA1a

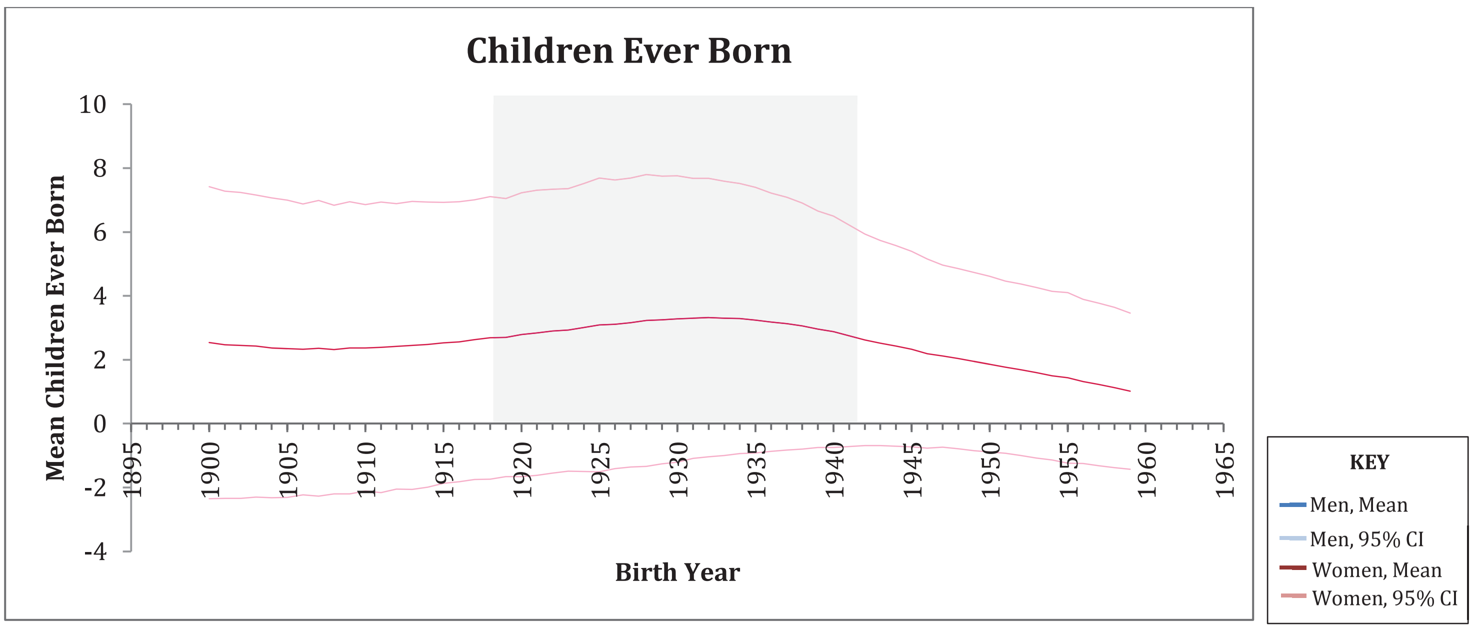


Figure WA1b

Figure WA1c

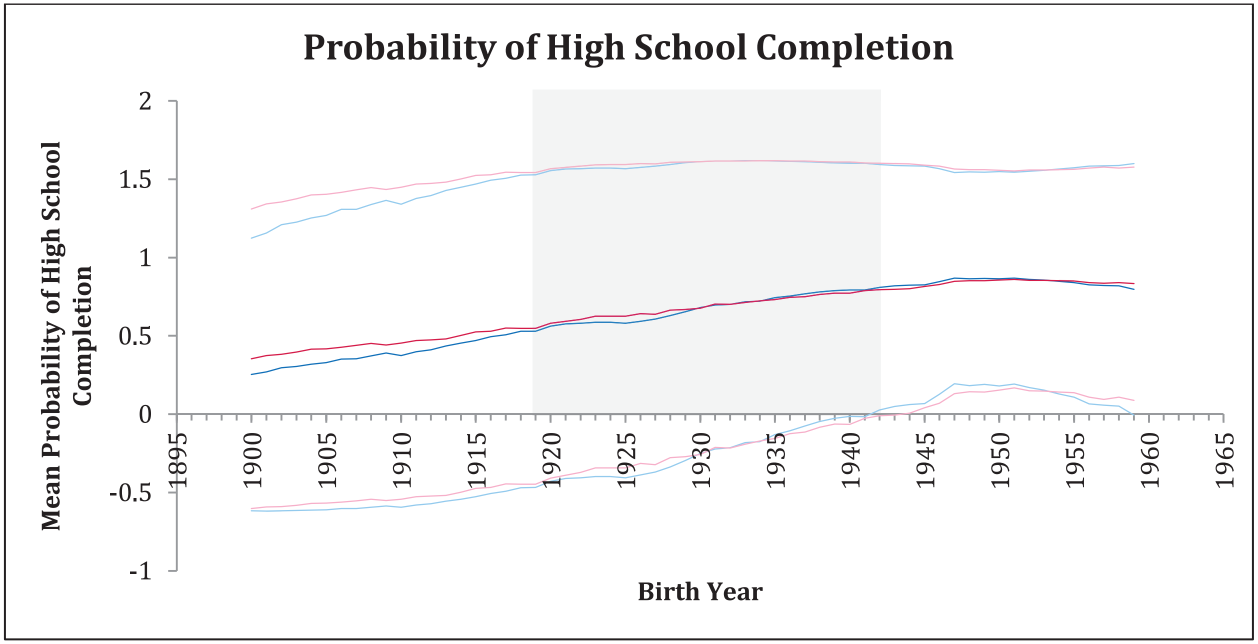
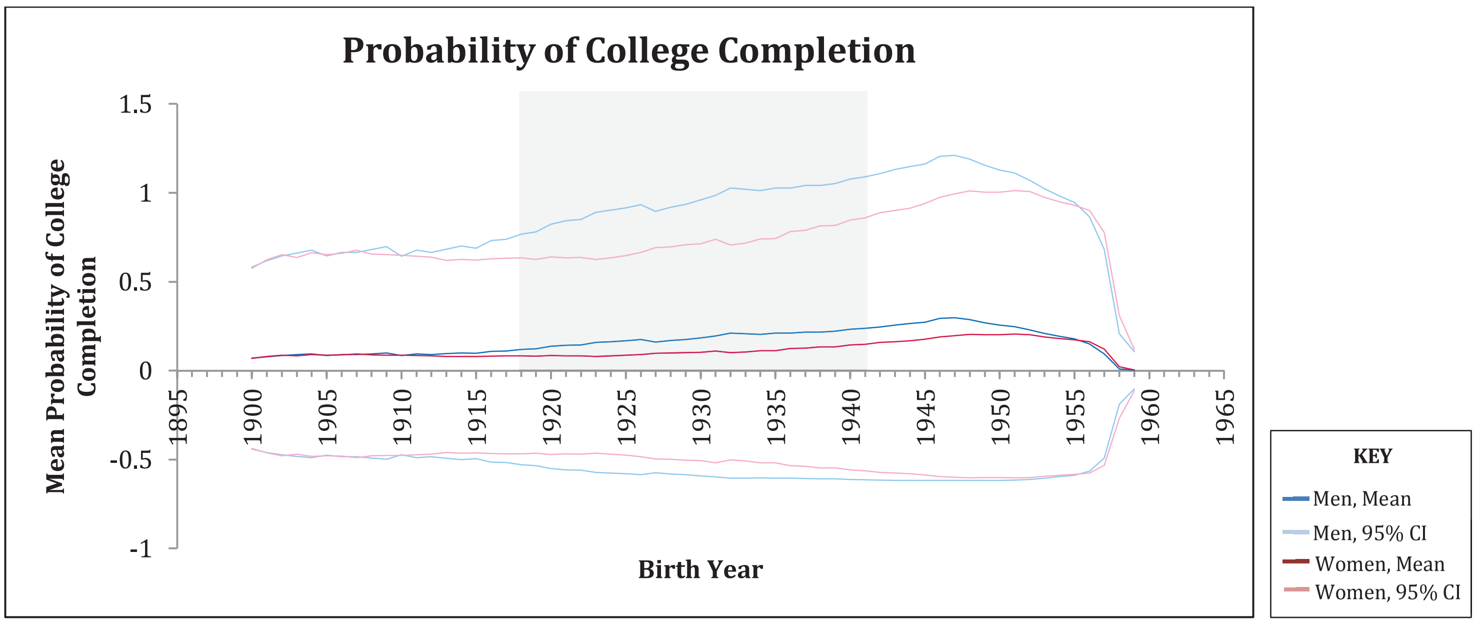


Figure WA1d



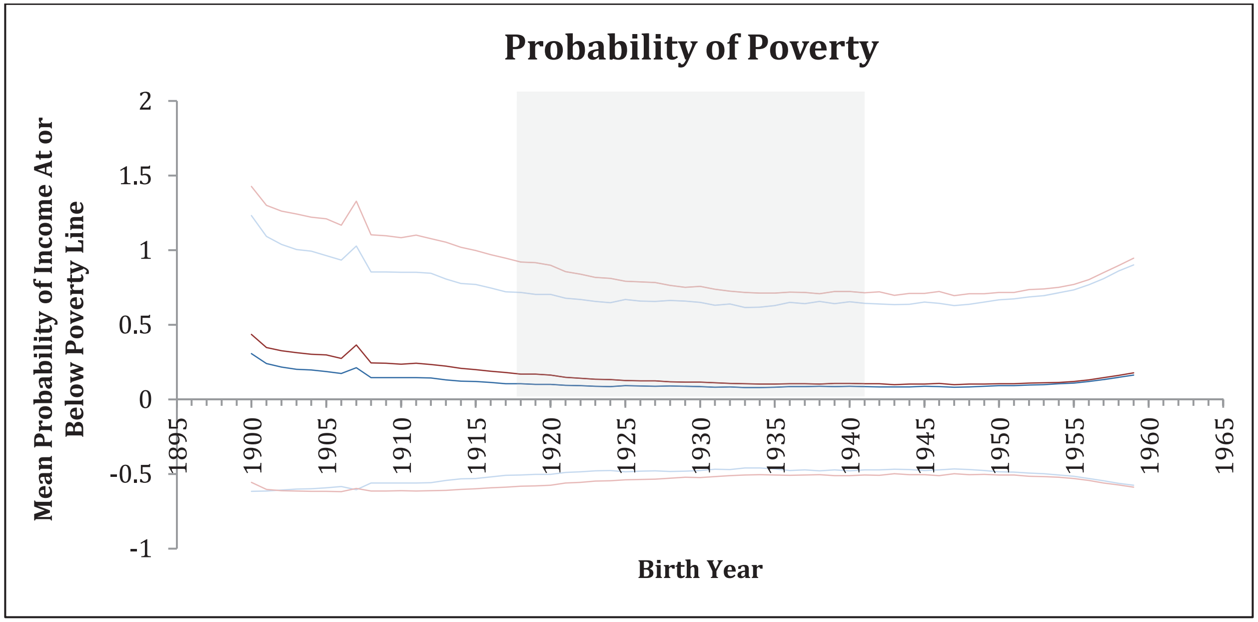


Figure WA1e

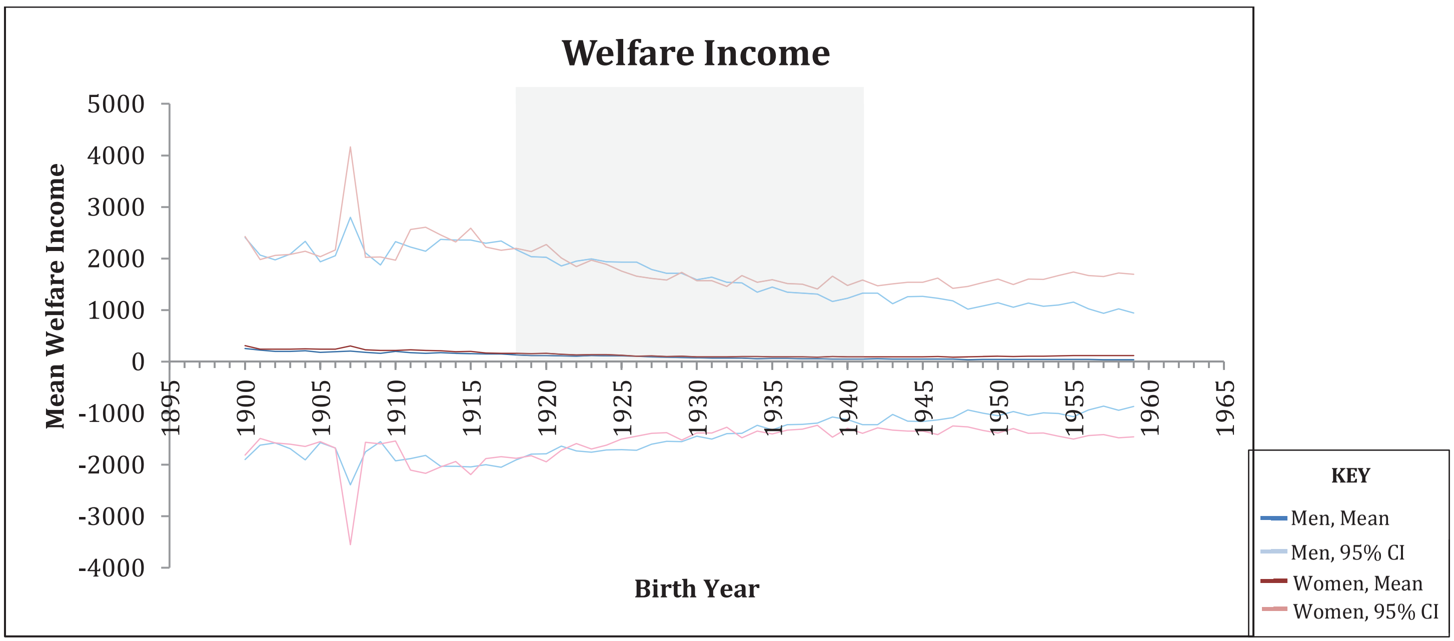


Figure WA1f

Figure WA1g

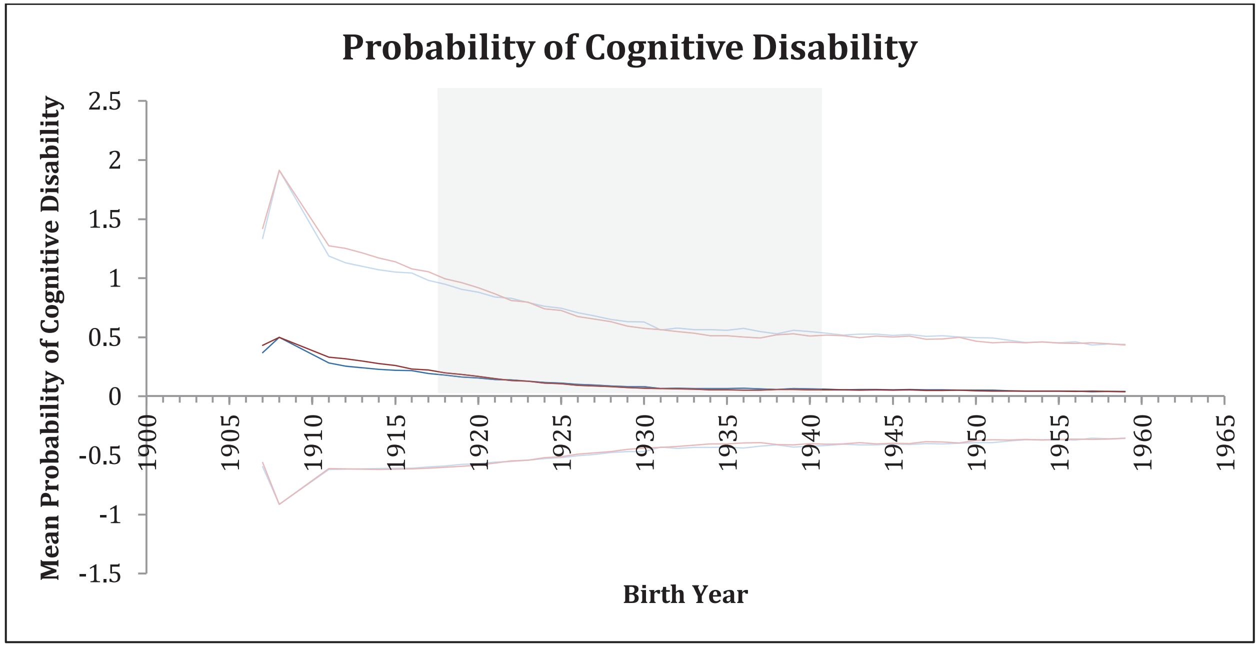


Figure WA1h

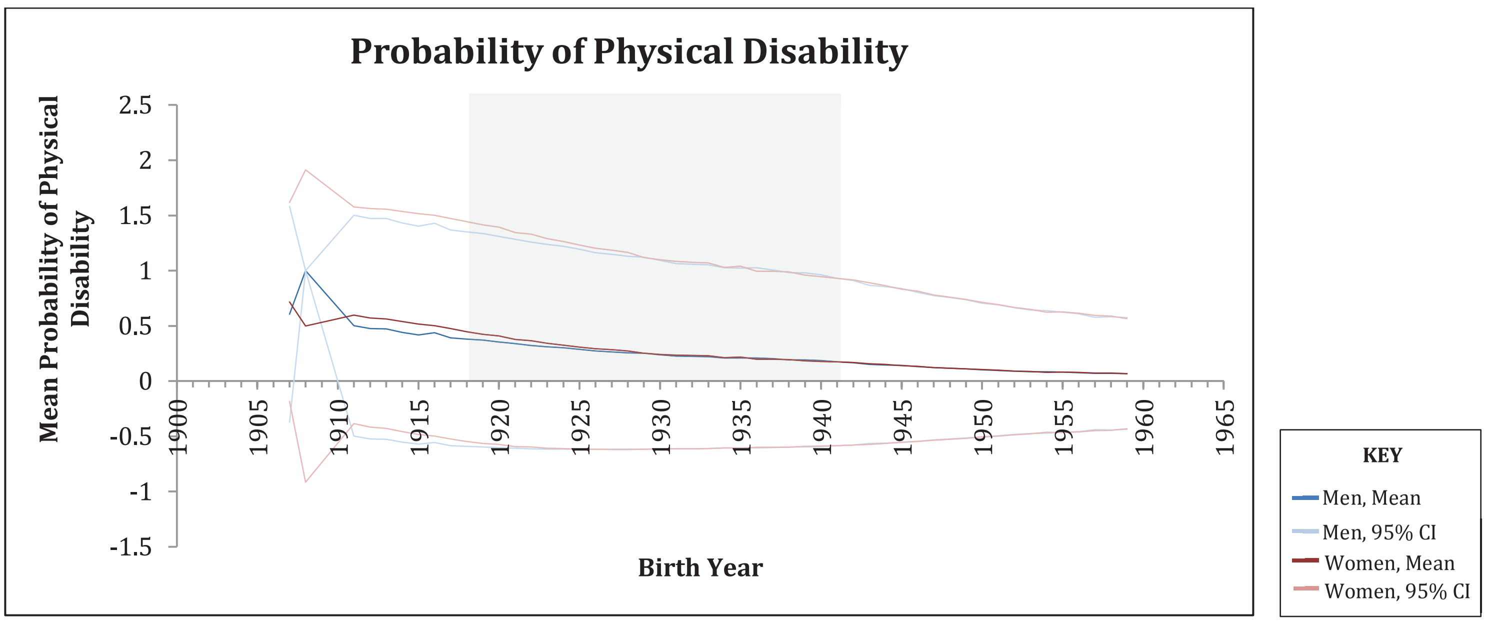


Figure WA1i

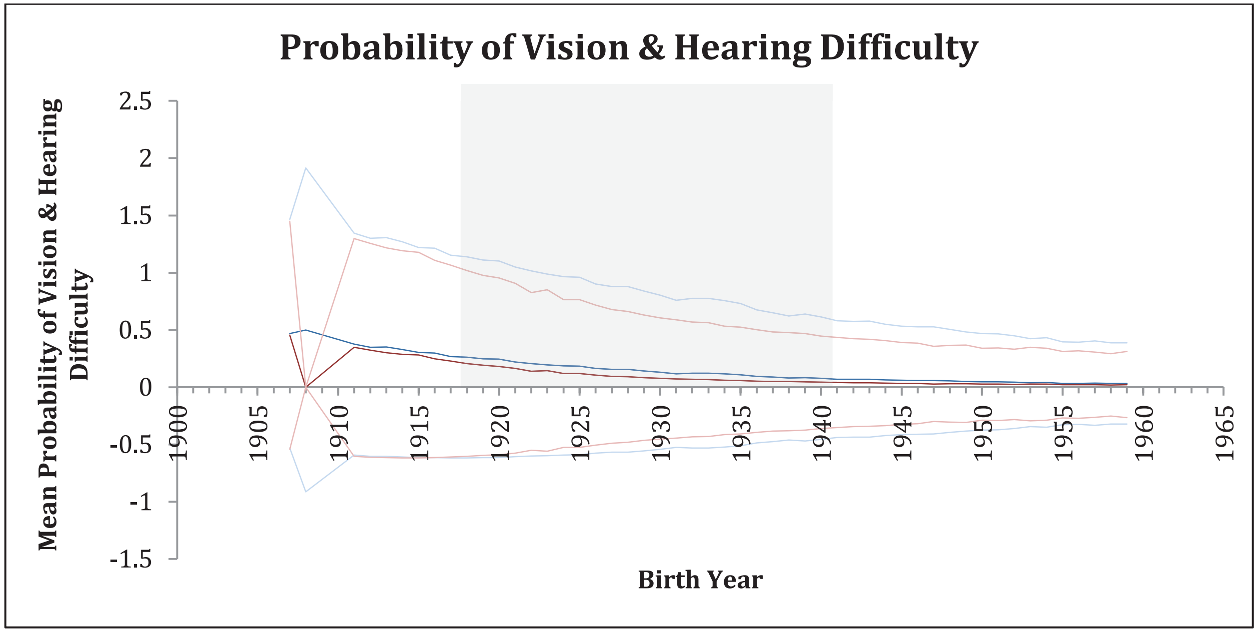
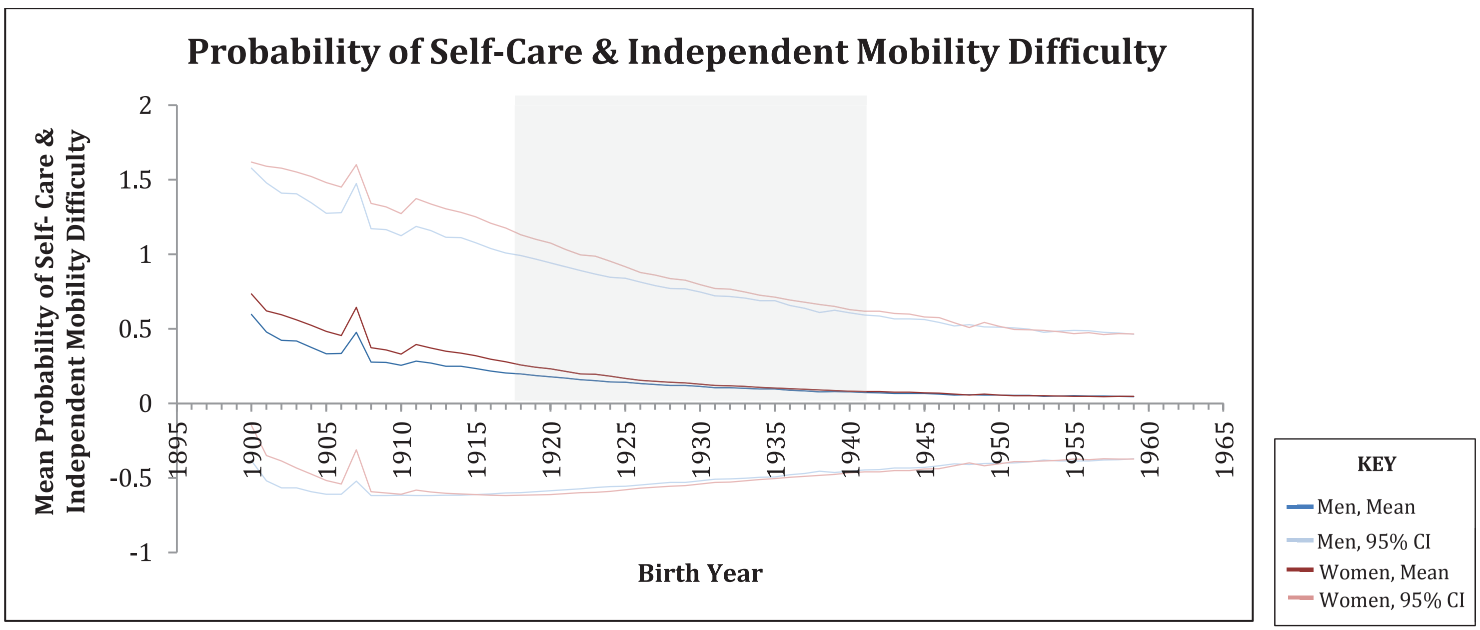


Figure WA1j



Figures WA2-12— Impact of Exposure to the Dust Bowl by Development Stage on Later-Life Outcomes

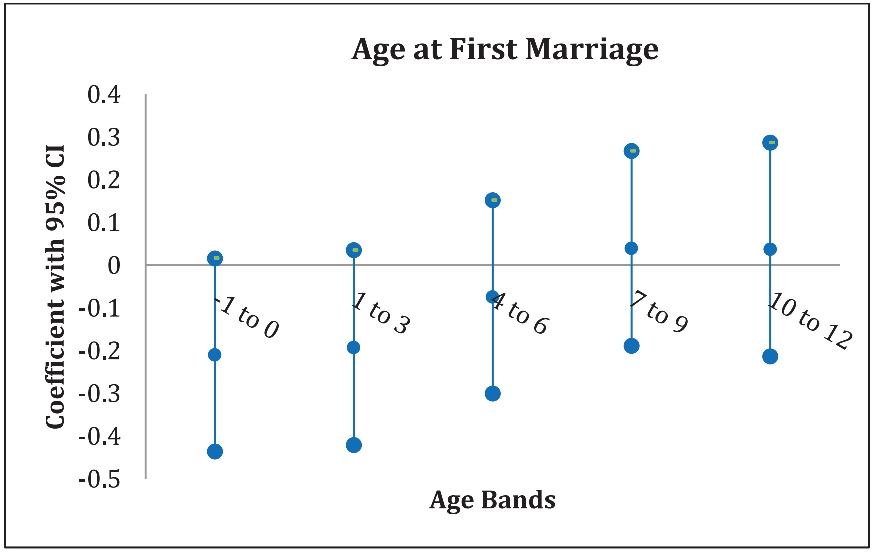


Figure WA2a: Men

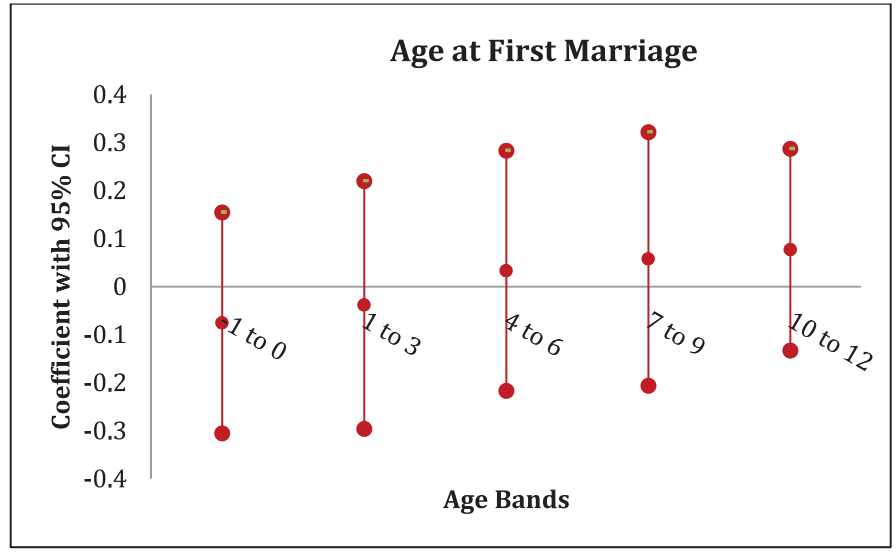


Figure WA2b: Women

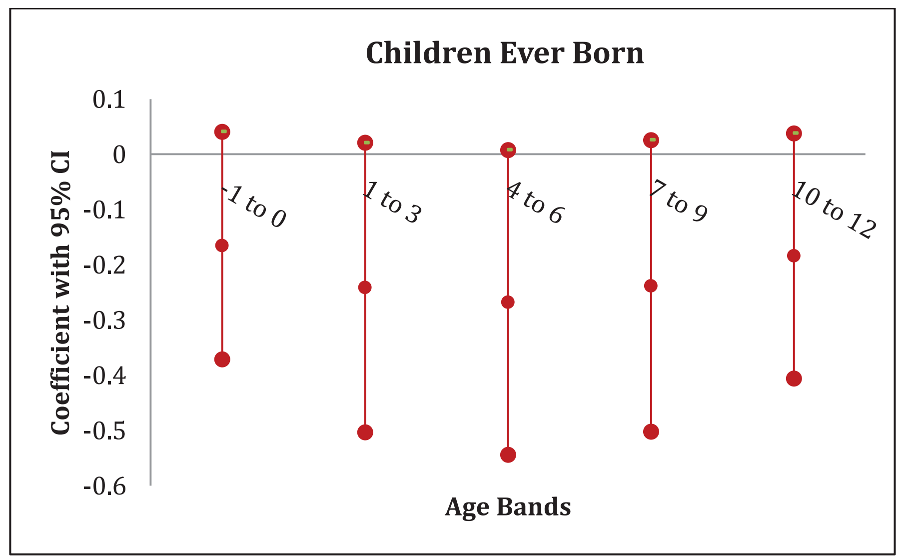


Figure WA3b: Women

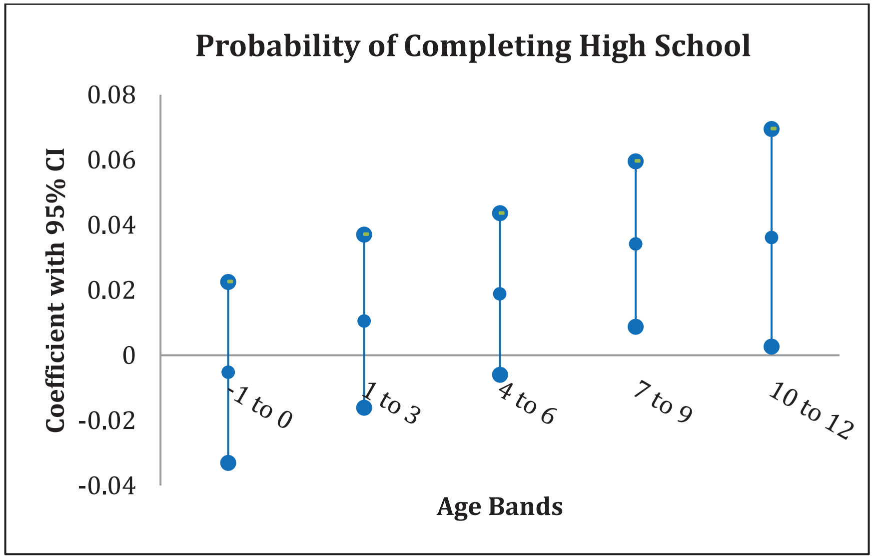


Figure WA4a: Men

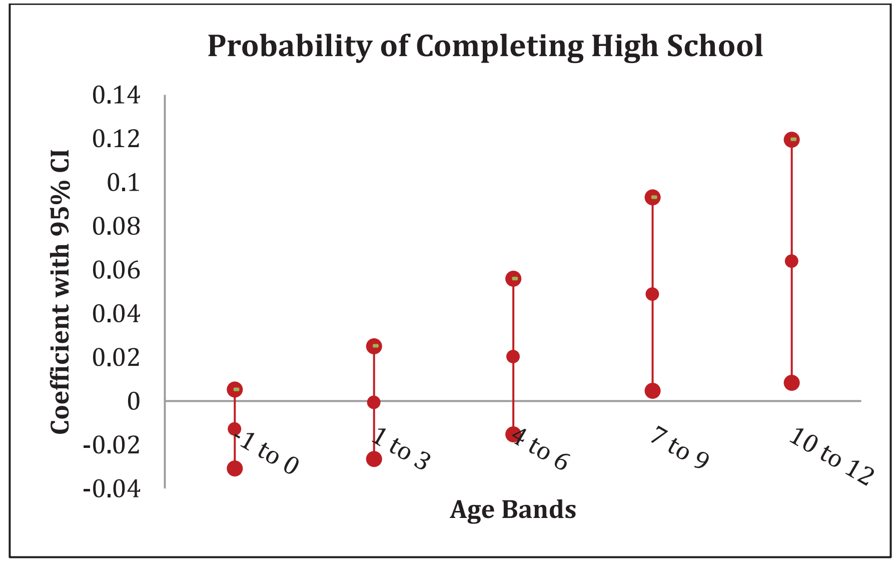


Figure WA4b: Women

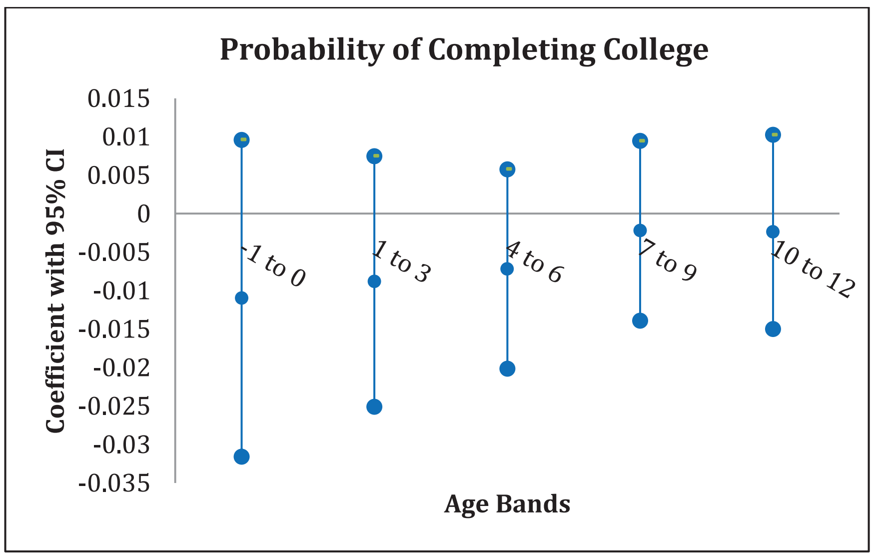


Figure WA5a: Men

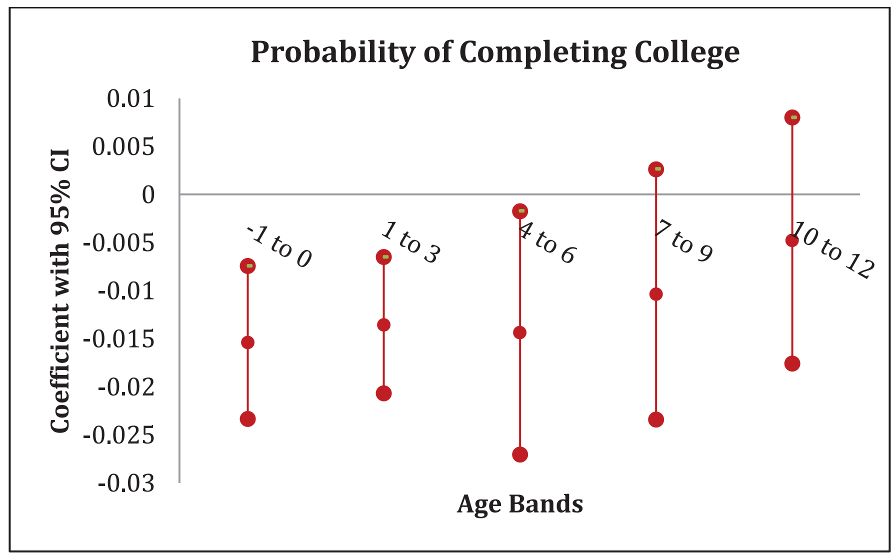


Figure WA5b: Women

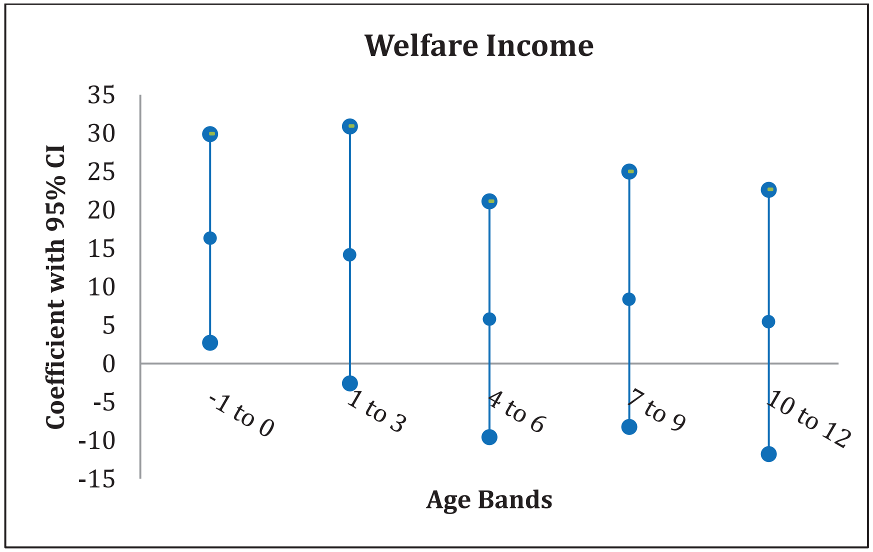


Figure WA6a: Men

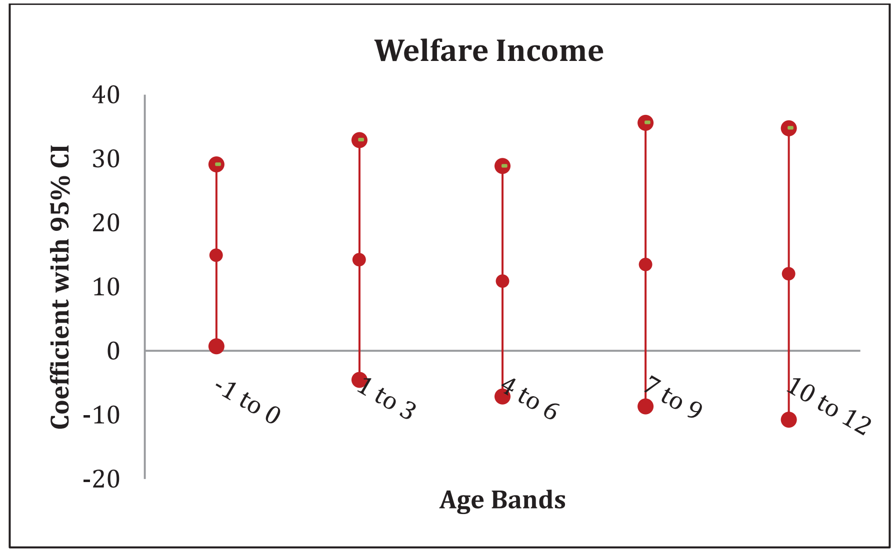


Figure WA6b: Women

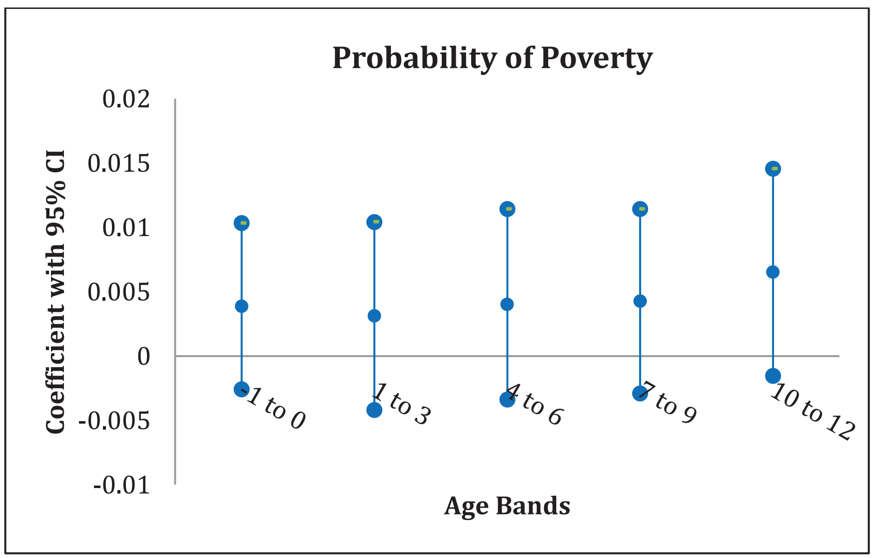


Figure WA7a: Men

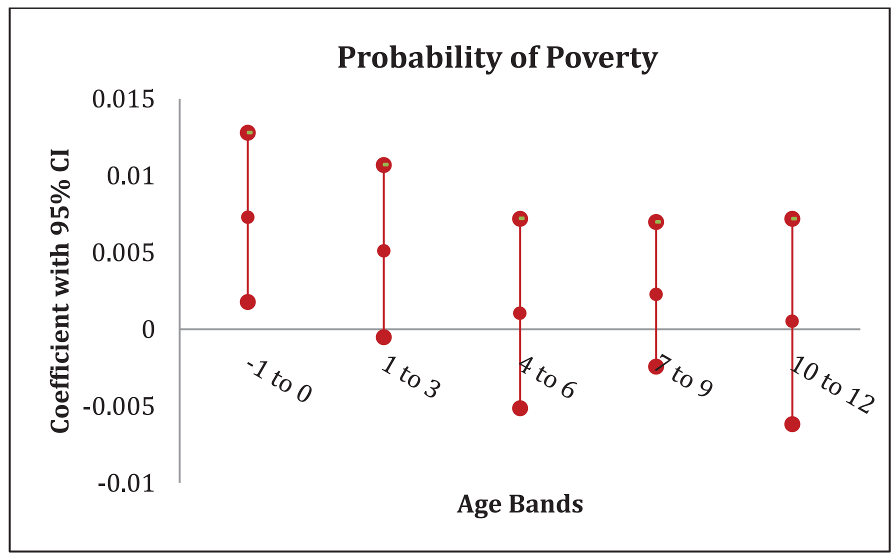


Figure WA7b: Women

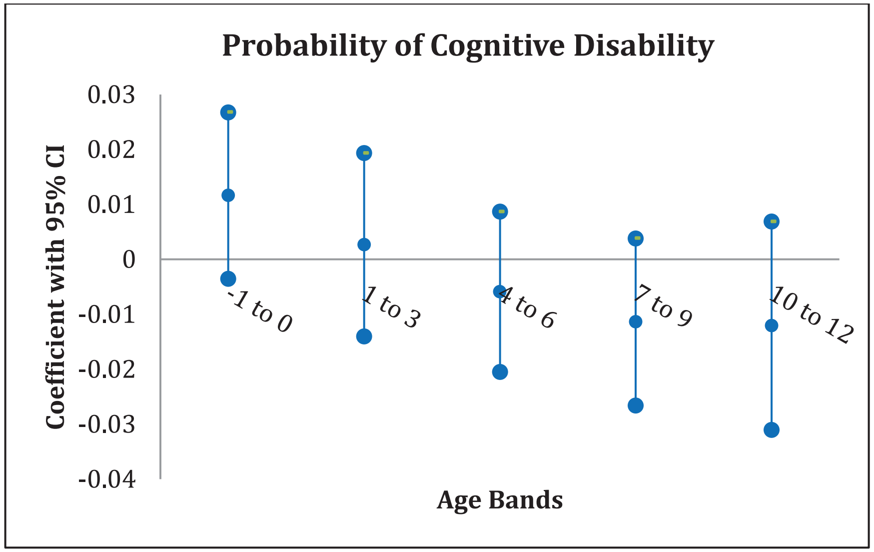


Figure WA8a: Men

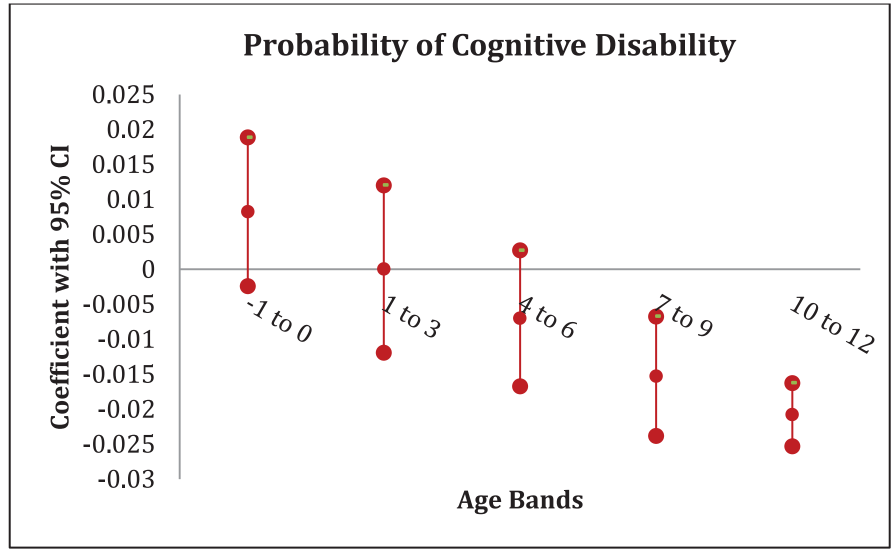


Figure WA8b: Women

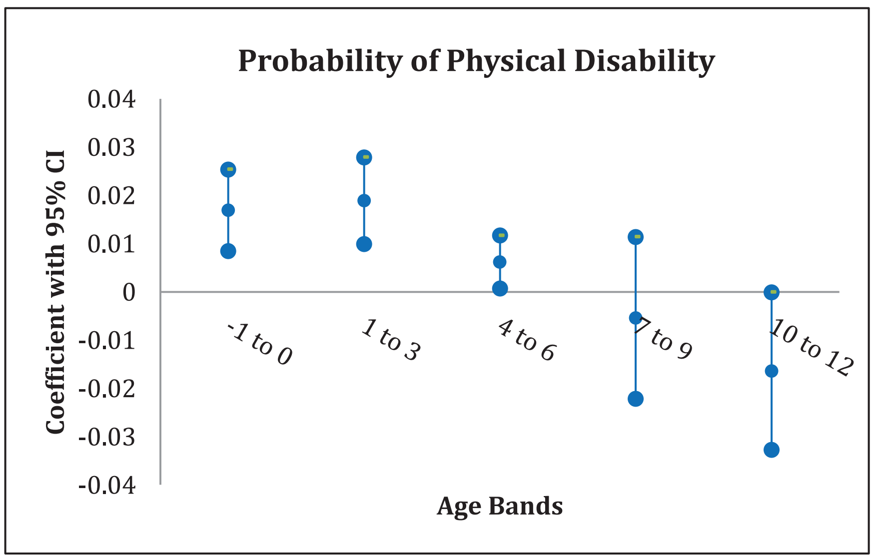


Figure WA9a: Men

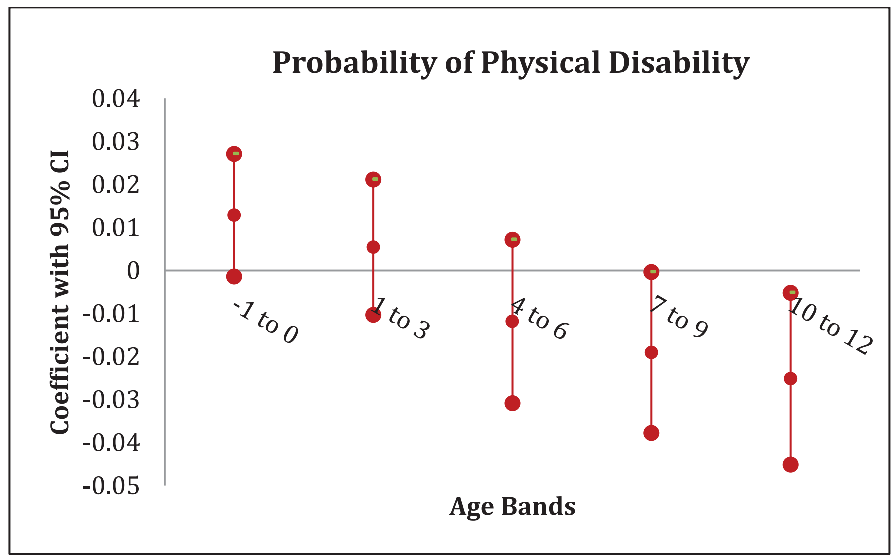


Figure WA9b: Women

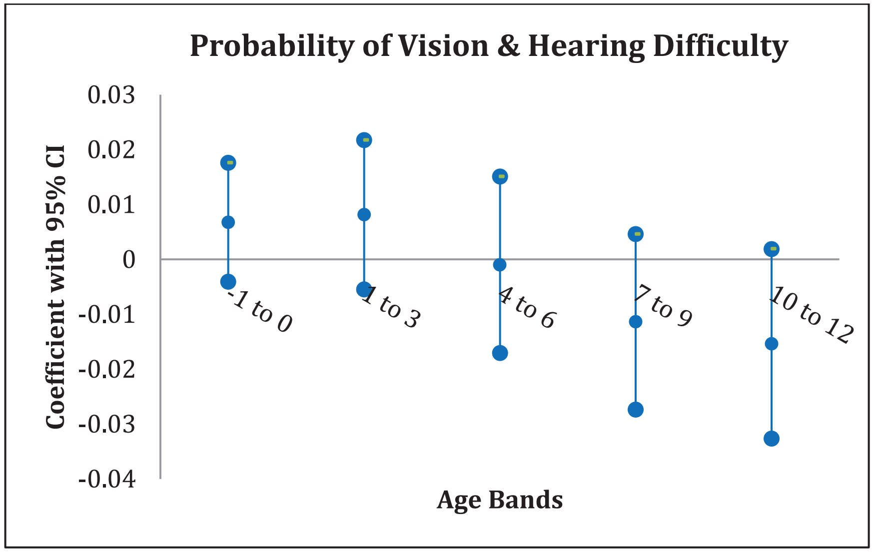


Figure WA10a: Men

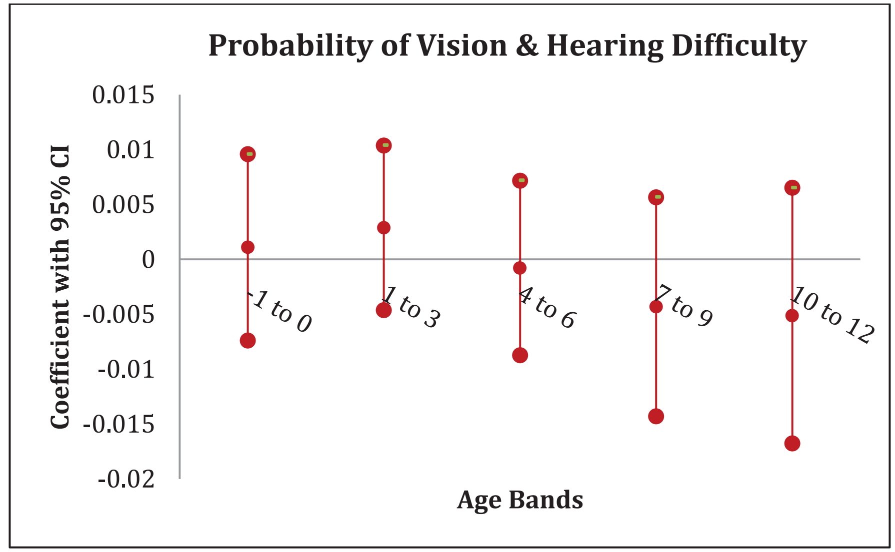


Figure WA10b: Women

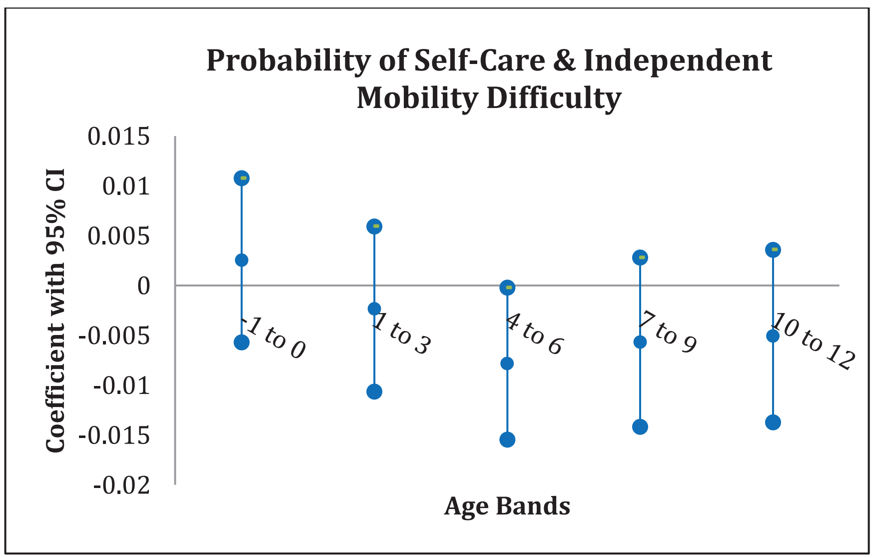


Figure WA11a: Men

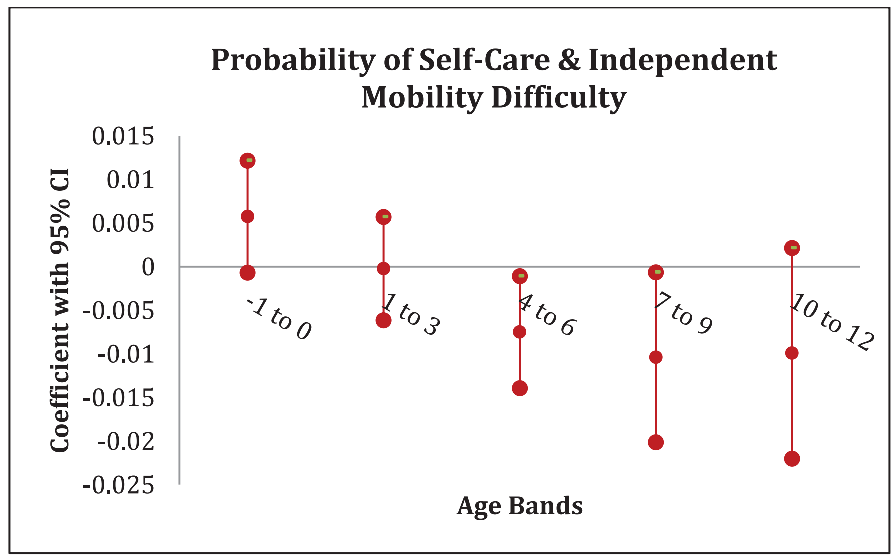


Figure WA11b: Women